COMPRESSED AIR MAGAZINE

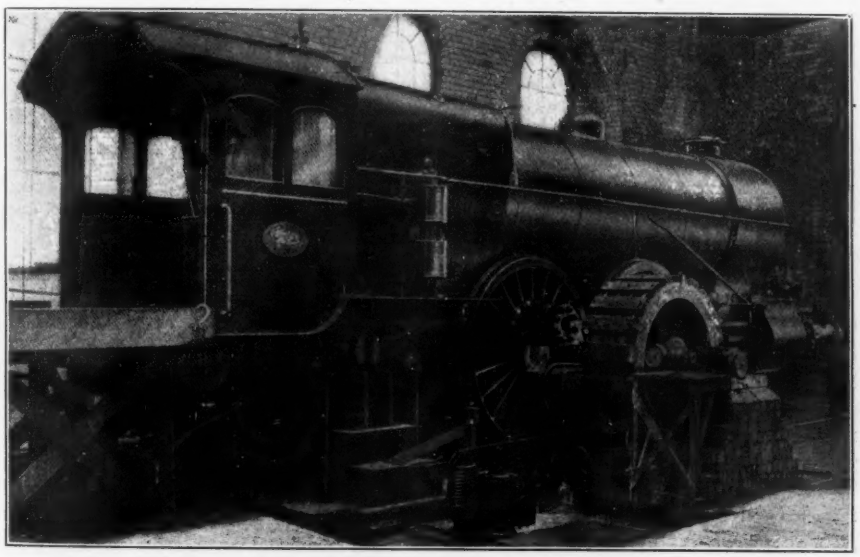
EVERYTHING PNEUMATIC.

Vol. XIV MAY, 1909 No. 5

POWER DEVELOPMENT WITH A MIXTURE OF VAPOR AND NATURAL GAS

It is now an established fact, that a *mixture* of vapor and neutral gas is a more efficient and a more economic working medium than steam alone or than gas alone.

About twelve years ago, the alcohol explosion engine was taken up in Germany, but with very little success and gave the very low efficiency of about 6 per cent. Later experiments showed the necessity of greatly increased *compression* of the mixture of alcohol vapor and air before explosion. Increased compression gave increased efficiency. When the necessary degree of compression had been determined by experiment, then came the more important question of the degree of dilution with water. The commercial alcohol in common use contained 90 per cent. alcohol and 10 per cent. water, but the experimenters increased the percentage of water and decreased the percentage of alcohol until it was found that 83 per cent. alcohol and 17 per cent. water gave the highest efficiencies. It is clearly obvious that the alcohol is burned to Carbon-dioxide gas while the water is converted into steam. After explosion, this 83 per cent. alcohol and 17 per cent. water produce the best ratio of mixture of steam and gas or vapor and gas to secure the highest efficiency. It is stated by the best of authority, that two gallons of gasoline will not produce as much work in a gasoline engine as

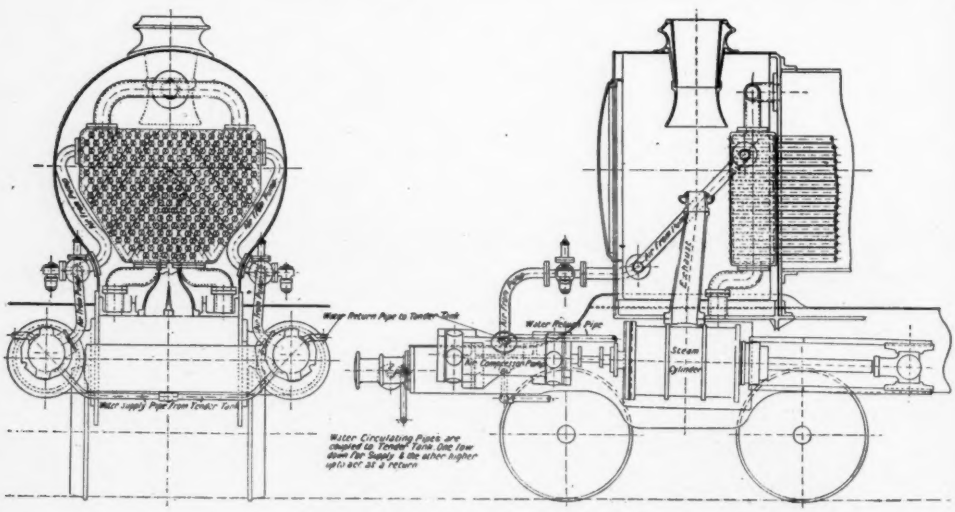


TESTING A STEAM-AND AIR LOCOMOTIVE

one gallon of dilute alcohol will produce in a specially constructed alcohol engine. The gasoline engine uses gas alone as its working medium while the alcohol engine utilizes a *mixture* of vapor and gas, or steam and gas, for its working medium; hence the greater economy.

Another demonstration of the higher efficiency of the *mixture* is shown by the locomotive in Fig. 1.

This locomotive is of the large Atlantic type and operates with a mixture of steam and compressed air or vapor and gas. Actual tests show a saving of 18 per cent. to 20 per cent. Other locomotives of the same character have been in continuous service for the last 16 months upon the British and Northern Railway in England.


Water Return Pipe to Tender Tank
Water Supply Pipe from Tender Tank
Water Circulating Pipes are coupled to Tender Tank One low down for Supply & the other higher up to act as a return
Water Pump
Steam Cylinder

SECTION OF STEAM-AND-AIR LOCOMOTIVE.

This locomotive has two cylinders in tandem, on each side. In the forward cylinder air is compressed to 200 lb. pressure, which is the steam pressure, and then delivered to a smokebox superheater where it is mixed with steam. In the rear cylinder the superheated air-steam mixture is utilized as a motive agent.

An outline view of this locomotive is shown in Fig. 2, both of these Figs. being reproduced from the *Engineer*, London. Fig. 2 will be recognized as having appeared with a somewhat unsatisfactory explanation in a previous issue.

As illustrated, the compression is performed by an external compressor cylinder placed tandem to the steam cylinder, which now operates with the mixture of steam and air, or, more generally speaking, operates with a mixture of vapor and neutral gas.

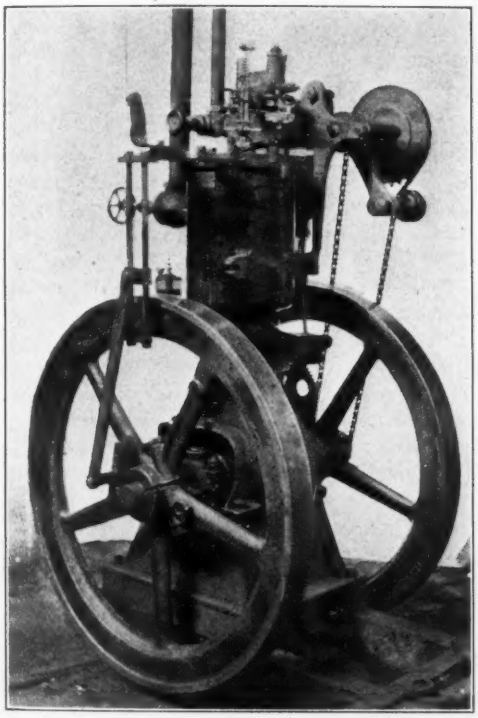
The latest experiments with the mixture of compressed air and steam, have been made by the "Christie Engine Company" of Marion, Iowa, and were conducted in the power house of the City Railway Company, at Cedar Rapids, Iowa, with the engine shown in Fig. 3.

This is a 6 by 8 in. vertical gas engine which was transformed into an air-steam engine, or a four-stroke-cycle steam engine. The operation is as follows: During the down stroke air is drawn into the cylinder; upon the up stroke the air is compressed; at the end of the stroke a valve opens to allow steam to enter and mix with the compressed air; the valve closes at some point in the down stroke, after which the mixture expands until the end of the down stroke; on the second up stroke, the mixture is exhausted from the engine, after which the process is repeated in order. No attempt has been made to determine the efficiency of the engine under consideration but indicator diagrams have been taken from it.

Fig. 4 shows a card with a very early cutoff, a compression of 55 lb. and a steam pressure of 65 lb. Fig. 5 was taken with a compression of 40 lb. and a steam pressure of 85 lb. and with early cutoff. Fig. 6 was taken under the conditions of Fig. 4 but with a late cutoff. Fig. 7 shows a late cutoff with a steam pressure of 130 lb. The speed of the engine was 125 r. p. m.

The chief merit of the Christie system is that it has the effect of giving a non-condensing engine all the advantages of a condensing engine without the necessity of a condenser or water for condensing purposes. The expanding air cools the steam, condenses it and decreases its pressure and temperature. The mixture of air and steam causes the steam to be superheated and the engine has the additional advantage of being supplied with initially superheated steam.

When air at 150 lb. is mixed with steam at 150 lb. the mixture will be at the same temperature as before for steam, but the air and steam

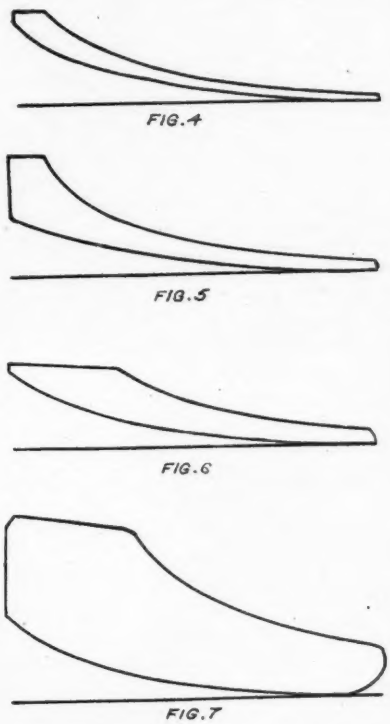


EXPERIMENTAL AIR-AND-STEAM ENGINE.

pressures will each be 75 lb. The total heat of steam at 150 lb. being greater than that for 75 lb. allows intrinsic energy to be so changed that the steam will be superheated about 50 degrees.

This four-stroke-cycle system, compressing the air *within* the steam cylinder, will clearly avoid many losses which must be sustained by the *external* compressor shown on the locomotive in Fig. 1 and 2.

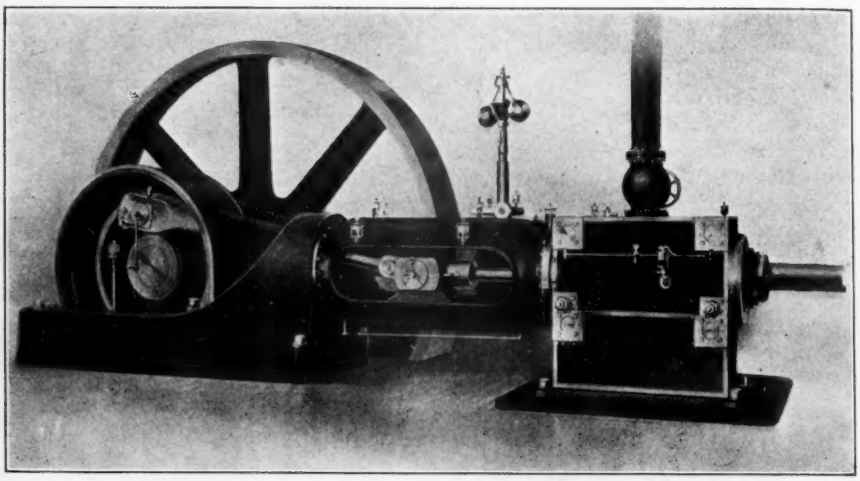
Larger and more important experiments are now proposed with the Corliss, four-stroke-cycle engine shown in Fig. 8. The air is introduced into this engine through an "Ingersoll-Rand" piston inlet valve; the piston tube extension is seen to the right of the cylinder. This engine will be tested by the Christie Engine Company at Marion, Iowa, under the supervision of Professor H. B. Mac Farland of Chicago.



AIR-AND-STEAM CARDS.

The economy of a mixture of vapor and neutral gas is fully explained by the fact that, during expansion, there is a heavy transfer of heat from the steam to the gas (or air) in the mixture, the heat which is transferred is strictly the latent heat of the steam and the same latent heat which would otherwise go out at the exhaust of a steam engine.

This transfer of heat from the steam to the compressed air in the expanding mixture, is clearly demonstrated by the temperature curves shown in Fig. 9. One cubic foot of steam at 50 pounds pressure expanding to 10 cubic feet,



CORLISS AIR-AND-STEAM ENGINE.

drops from 230 degrees to 150 degrees; but one cubic foot of compressed air at 50 pounds pressure expanding to 10 cubic feet, drops from 280 degrees down to 165 degrees below zero. If the two were mixed at the same pressure and temperature, it must follow that the air could not grow so extremely cold but must receive a large amount of heat from the steam. This means practically the reheating of the compressed air throughout the entire expansion, and the high economy of reheating compressed air is fully set out in Chapter XVII, Richards on Compressed Air.

The laws for steam alone are well known, also the laws for gas or air alone, but the only laws for a *mixture of vapor and gas* are the laws of Gay-Lusac or Dalton.

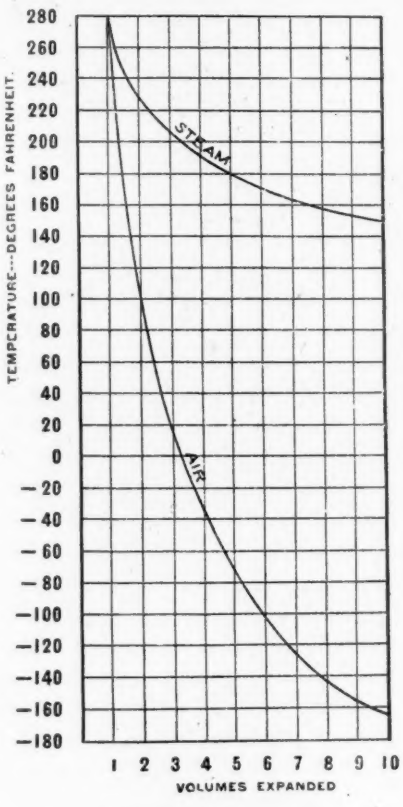
All saturated mixtures of vapor and gas obey the two following laws:

DALTON'S LAWS.

FIRST: The pressure, and, consequently, the quantity, of vapor which saturates a given space, are the same for the same temperature, whether this space contains a gas or is a vacuum.

SECOND: The pressure of a mixture of a gas and a vapor is equal to the sum of the pressures which each would possess if it occupied the same space alone.

This is practically a new field of research, and the *mixture of vapor and gas* may be introduced into several new systems of motive



COOLING IN EXPANSION.

power. In fact, the Christie Engine Company has already devised three separate and distinct systems to use the mixture, and all will be tested in the near future.

LAKE COPPER

The term "Lake Copper" came into use to designate the output of the Lake Superior copper district of northern Michigan. Owing to the fact that this Michigan copper was fundamentally different in its natural state or occurrence from that of most other copper districts, it was amenable to a process of refining which was different, both in operation and in standard of excellence, from the methods employed in refining copper from other regions. The consequence was, that this Michigan product was of somewhat different character and quality from copper produced elsewhere. The term Lake copper, therefore, in addition to its purely geographic significance, soon came to imply a particular grade or quality of copper, and it is undoubtedly in this double sense that the term has been generally used. So long as the actual character of this Michigan copper remained different and distinct from that of other copper, this dual significance of the term Lake copper caused no confusion. But with changing conditions that have affected both the Lake Superior product and that from other districts the early and established meaning of the term has been so warped and expanded that now in many cases it is impossible to decide from the name alone just what so-called Lake copper really is.—*Mining Science.*

BAROMETRIC CHANGES AND COAL MINE ACCIDENTS

The following is reproduced, with slight verbal changes and some condensation, from a contribution to *Copper Age,* Butte, Mont., by Mr. M. H. de Hora.

Every well-equipped coal mine should have at least two reliable mercurial barometers on the plant, one at the surface, preferably in the foreman's or manager's office, and one at the workings easily accessible to the shift-boss or underground mine captain.

One would think that if there was a class of people to whom the state of the weather made less difference than to another, that class would be miners. Working underground it is all one to them whether the sun shines or the rain pours, as at a few hundred feet below the surface, the thermometer remains about the same from one year's end to another; consequently, it makes no odds to the miners whether on the surface the heat be oppressive or whether the thermometer is below zero; but there is one class of miners, namely colliers, to whom a sudden change of weather means danger, often death, and certain material damage and delay occasioned by explosions.

Most of the horrible accidents occurring in coal mines can be proved to have been in a great part occasioned by sudden changes in the weather. We all know what happens when the barometer falls. It means principally that a load of air is being removed from above us. If the glass falls an inch, say from 30 to 29, it means that a weight of no less than 72 pounds has been removed from every square foot of surface, where atmospheric air is accessible.

This is how the fall of the barometer affects the coal miners. Coal is full of inflammable gases, of which the principal and most prevalent is that known to the miners by the significant name of "fire damp." When a seam of coal is being worked, the breaking out of the coal releases it from an enormous superincumbent pressure. This causes the gas to gush forth with such strength that at times it hisses and roars like steam escaping from a safety valve. As long as this gas is unmixed with atmospheric air, it is non-explosive. Its only fatal action is merely suffocating; but when combined with air it forms a powerful explosive mixture, and is the chief cause of the mine disasters of which the list is so long and deadly. Now, the earth and the coal within it are equally affected by the diminution of pressure, of which the symptom is a heavy fall of the barometer. The removal of external pressure allows the gas that is in the coal to escape more easily. It is like the unscrewing or unweighting of a safety valve, with the consequent opportunity offered for the imprisoned steam to rush out; therefore the fall of the barometer corresponds with the unscrewing or the unweighting of the safety valve and the release and dangerous increase of inflammable fire damp mixed in the workings of the coal mine; and consequently the least spark, whether from a charge being fired

or from a nailed boot treading on a piece of flinty rock, or even the spark arising from the jar of the point of a pick and from many other causes, will result in a fearful explosion. Many cases can be cited to prove that a decrease of atmospheric pressure is the invariable precursor of explosions in coal mines.

The most dangerous mixture of fire damp and atmospheric air is eight of air and one of fire damp, and it has been within the knowledge of experienced miners for more than thirty years that this mixture is more readily reached when the atmospheric pressure is low than when it is high. Rapid changes in the humidity of the air which is drawn from the surface by the ventilating of the mines causes dangerous transformation in the state of the floating dust; consequently, it becomes a most important duty of the coal mine manager and his subordinates to consult the barometer with as great care and attention as do the captain and officers of a ship, so that they can exercise that just prudence and precaution so necessary to avoid accidents.

AIR COMPRESSOR LUBRICATION

There is always a lurking danger where oils are used for lubricating air compressor cylinders, especially where the poorer grades of oil are employed. As our readers are frequently reminded many disastrous accidents have been traced to receiver or pipe line explosions caused by the vaporization of lubricating oils. There is also apt to be more or less trouble from the formation of hard carbon deposits. Instances are on record where it has been necessary to shut down and chisel the carbon deposit off the piston and valves.

By using Dixon's Flake Graphite and oil fed by means of a Graphoil Lubricator troubles with carbon deposits and dangers of explosion are reduced to a negligible quantity. Some concerns have advised the Dixon Company that instead of oil they have used soapsuds with flake graphite and have secured perfectly satisfactory results.

The booklet "Air Compressor Lubrication" published by the Joseph Dixon Crucible Company of Jersey City, N. J., contains much valuable information on the subject of air compressor lubrication besides suggestions for the best ways to feed the graphite. This booklet will be gladly sent to those interested who will write direct to the Dixon Company.

A METHOD FOR DETERMINING THE NUMBER OF DUST PARTICLES IN THE AIR*

By C. E. A. Winslow.

In many branches of sanitary work, notably the study of factory conditions, measurement of dust suspended in the air is of great importance. The actual number of dust particles present is probably quite as significant as the total weight of suspended matter. With dust of a given nature, it seems probable that damage to the lungs increases in proportion to the number of particles which lacerate their surfaces. Curiously enough, however, the enumeration of dust particles has not found place in most studies of ventilation problems. In some recent work carried out at the Sanitary Research Laboratory of the Institute of Technology, a method has been devised for this purpose.

The method consists in drawing a measured volume of air through a filter of granulated sugar, dissolving the sugar, suspending the contained dust in a known volume of distilled water and counting the dust particles present under the microscope. The sugar may be ordinary granulated sugar, the grains of which vary between 0.25 and 1 mm. in diameter. The layer of sugar should be 2 c.m. deep, and may be held in place in a glass tube of 1 to 2 c.m. base, by a perforated stopper and a square of bolting cloth. The air sample should be collected rather rapidly; and this may be done by the use of a suction cylinder of metal, with a closely fitting piston. After sampling, the sugar is poured into a small graduate and dissolved in 5 to 10 c.c. of distilled water. After thorough agitation 1 c.c. of the resulting suspension of dust in water is placed in a Sedgwick-Rafter counting cell, such as is used in the microscopical examination of drinking water. This cell is 50x20 mm. in area, and 1 mm. deep. The general method used in enumerating the dust particles is that described by G. C. Whipple in the "Microscopy of Drinking Water," for the study of the microscopical organisms. It involves simply the counting of the number of dust particles in a certain number of representative squares, and the calculation of the number originally present in the filtered air. In should be noted, however, that both the bottom of the liquid and its surface should

*A paper before the American Public Health Association, Winnipeg, Manitoba.

be examined. Heavy dusts, of course, settle to the bottom, but lighter dusts may be found exclusively at the top of the counting cell.

In my work I have filtered 600 c.c. of air and dissolved the sugar in 6 c.c. of water, thus giving a concentration of 100 in 1. I count 10 sq. mm. areas in the counting cell of 1-100 of the total number present in 1 c.c. of the concentrate. The number of dust particles thus counted corresponds directly to the number of dust particles in 1 c.c. of the original air.

It is, of course, essential that glassware and sugar should be clean, and it is desirable that control determinations should be made in order to avoid errors due to extraneous dust. I have found that 5 to 10 dust particles per square is an outside limit for this error with ordinary cleanliness. This corresponds to 50 to 100 dust particles per c.c. of air, and the method cannot probably be relied on below these limits.

Even with this qualification, however, the direct enumeration of dust particles offers a very delicate method for measuring dust in air. I have compared it with the method of weighing, with the following results, using dust swept up from the floor of the laboratory and shaken up in a large bottle, to give an extreme condition of dustiness. I found in one case that 16,000 dust particles per c.c. corresponded to a weight of 3 mg. In another case 13,000 particles per c.c. corresponded to a weight of 10 mg. With the dust method one can easily estimate numbers of dust particles down to 100 per c.c., which would correspond, in the case of the dust studied, with weights of 1-100 mg. or less, amounts which could hardly be determined accurately by the ordinary methods of filtering and weighing.

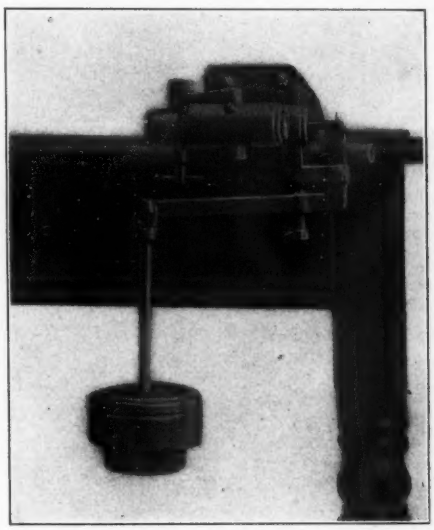
An additional point in favor of the method of enumerating dust particles is the opportunity for observing the nature of the particles themselves.

Their size may also be estimated if desired. The standard unit used in the microscopical examination of water (see Whipple), may be used for this purpose. It is not suggested that the enumeration of dust particles should in any way supplant the determination of the total weight of dust present. It is rather urged that it should be used in combination with the usual procedure for additional information.

AIR COMPRESSOR UNLOADER

The half-tone shows an unloader made by the Hunneymen Company, Concord, N. H., and designed to be applicable to any ordinary compressor.

In the main portion of this device are two cylinders with pistons ground to a fit. The main piston connects directly with the air tank, and the weights are so arranged as to control the air pressure within the desired limits. When the maximum pressure is reached the weight rises and allows the main piston to move and uncover the ports which connect



AIR COMPRESSOR UNLOADER.

it with the smaller piston. This is moved in turn and connects with the air pressure from the tank, and this reaches the valves of the air compressor, completely unloading it. The variation between maximum and minimum pressures may be from 4 to 20 pounds, but experience has shown that about 6 pounds is the most desirable for general use. After the compressor has unloaded and the pressure has been reduced the desired amount, the weights overcome the air pressure on the main piston and allow the small piston to return to its starting point. The compressor then gets to work again, and in this way the air pressure in the tank is controlled without waste of power, as is the case when the safety valve is used on the tank. The second or auxiliary valve connects the unloading valve directly

with the air tank, so that its action is dependent entirely upon the pressure of air it contains. This can be arranged to control either the inlet or the discharge valve of the compressor as may be desired.

PHOTOGRAPHING UNDER AIR PRESSURE

Mr. William Munson Christie, LaGrange, Ill., in a valuable article on "Engineering Photography" in the *Engineering Record* of April 3, speaks of the special conditions attending the practice of photography in caissons, subaqueous tunnels and such places where the work must be done under abnormal air pressure.

The taking of such photographs, the writer says, is, at best, an unpleasant proposition and to one who has never experienced the conditions prevailing in this class of work, the job is not only unattractive, artistically and financially, but, also, it is a work attended with many dangerous risks. If one passes through the air-lock without getting "blocked," the after effects of the abnormal air pressure on the body are not pleasant. I have experienced these effects two and three weeks after being under air pressure ranging from 10 to 25 lb. And then again, these effects will pass away in a few hours or a day or two, depending, I presume, upon one's physical condition at the time of going under the air pressure. These after effects manifest themselves in a languor, more or less pronounced, symptoms not unlike those of malaria. Those who follow work, or are engaged in work carried on under air pressure, eventually are compelled to give it up. Laborers employed in this work often get what they call "the bends," a muscular or nervous disorder, affecting the lower extremities and, of course, the entire system. Pathologically speaking, it is a form of paralysis. The expressions, "the bends" and "blocked," are colloquialisms. Getting "blocked" is caused when entering the air-lock, or more definitely speaking, when passing from the normal to the abnormal air pressure the process of equalizing the air pressure on the ear drums and air passages in the nose and head is checked or stopped, or, in the expressive term, is "blocked." This results in piercing pains in the ears and across the eyes and through the region of the temples, and frequently in hemorrhages.

Another difficulty often attending photographic work under air pressure is the fact that the air in the tunnel or caisson is very frequently filled with fog, making it impossible to get clear, distinct pictures. This fog condition varies with the seasons of the year, the atmospheric conditions, the temperature outside, and whether it is cloudy or bright. I have been in caisson work where the temperature was as high as that of a Turkish bath. Emerging from the air-lock under such conditions into the frosty air of winter is like stepping from the tropics to the north pole.

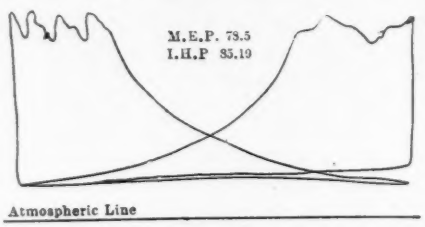


FIG. 1

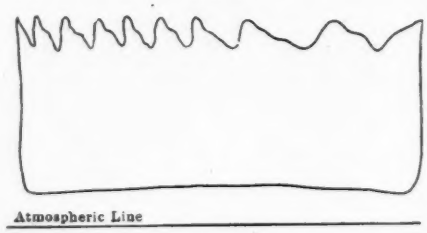


FIG. 2

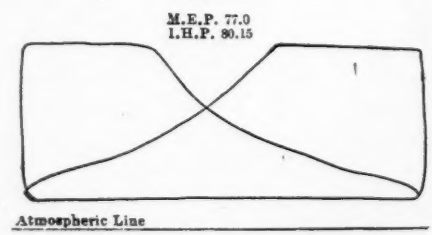


FIG. 3

STEAM SUPPLY IRREGULARITIES.

EFFECT OF IRREGULAR STEAM FLOW

Those who have to do with compressed air are sufficiently familiar with the jagged delivery lines so frequent on the air cylinder cards. The cards which we here reproduce from *Power and the Engineer* are from an air compressor, but are steam cylinder cards and therefore are a curiosity.

A 6-inch steam main from a battery of Heine boilers feeds, by means of a branch pipe, a 30 and 52 by 48-inch cross-compound noncondensing direct-connected engine. The

pipe then diminishes in cross section and supplies an Ingersoll-Sergeant 16 and 32 by 36-inch cross-compound noncondensing air-compressor engine with Corliss valves.

When the dynamo engine is running, the intake line of the second engine shows considerable vibration; when the dynamo engine is not running, the intake line of the compressor engine becomes straight.

In Fig. 1 is shown a diagram of the high-pressure cylinder taken from the compressor engine when the dynamo engine was running under usual conditions. Fig. 2 shows a diagram taken under the same conditions, but with a 100 per cent. cutoff to show distinctly the characteristic vibration of the intake line on the compressor. Fig. 3 shows a normal diagram of the same cylinder, the compressor working under the same load, all the conditions being the same as in the first case, except that the dynamo engine is not running.

During these trials the dynamo engine made 103.5 revolutions per minute, developing 156 horsepower. The compressor engine made 23 revolutions per minute, compressing 750 cubic feet of free air per minute to an average pressure of 87 pounds.

The second diagram shows nine vibrations. Multiplied by 23, the number of revolutions per minute, gives 207 double vibrations per minute, which exactly corresponds to the number of strokes of the direct-coupled dynamo engine.

A comparison of the energies used in the compressor in the cases of Figs. 1 and 3 gives the following difference in favor of Fig. 3: Fig. 1, high-pressure cylinder, 86.193 horsepower; low-pressure cylinder, 75.33 horsepower. Fig. 3, high-pressure cylinder, 80.154 horsepower; low-pressure cylinder, 74.25 horsepower.

The vibration of the steam pressure in the main in this case causes a loss of about 4.4 per cent. in the efficiency of the compressor engine.

W. N. Polakov.

New York City.

In removing some natural cement concrete work in the harbor at Brest, France, which had been covered with sea water for 100 years, iron bars found embedded in this concrete, did not show the least indications of rust.

IGNITION OF FIREDAMP MIXTURES BY INCANDESCENT ELECTRIC FILAMENTS AND SPARKS*

The French Committee appointed to visit the Frameries testing station, having stated in its report that the results of the tests made there with reference to the ignition of firedamp mixtures by incandescent electric filaments and sparks, appear to contrast decidedly with the conclusions formed by Couriot and Meunier in 1906, namely, that sparks alone are capable of producing such ignition, an incandescent lamp filament having no such effect, the authors desire to correct the erroneous impression this unqualified statement is calculated to produce. They were the first to observe the possibility of maintaining the incandescence of the filament in an explosive mixture, and their experiments on this point led to the discovery of the superficial combustion of the inflammable gas around the incandescent filament—a phenomenon explained by the attraction of oxygen toward the filament. This attraction changes the proportions of the explosive mixture, so as to form an inexplosive sheath of gas; though if the incandescence and the radiation of heat are sufficient to raise the surrounding explosive mixture to the ignition point, an explosion will ensue. This result was observed by Heise, who used filaments of larger diameter than those employed by the authors, whose results with small filaments have recently been confirmed by Hauser.

The authors' tests that are suitable for comparison with those of Stassart were carried out with portable electric lamps supplied by the Arras Company, consuming 4 volts and 0.38 ampère. The mixture used contained exactly 9.5 per cent. of methane, as compared with Stassart's 8 per cent. mixture. In the authors' tests the filament was heated to redness in the mixture, but no explosion occurred until the filament broke; and therefore the explosion must be ascribed to the spark passing at the moment of rupture. Whichever be the true cause, however, the result is practically the same, since an exposed lamp filament will burn through in a few seconds and produce a spark. The difference resides in the interpretation of the physical phenomenon; and this is by no means negligible, as it is essential to

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*H. Couriot and J. Meunier. *Bulletin Soc. Industrie Minerale.*

know the exact manner in which the phenomenon occurs, not only from the point of view of safety, but also for other practical reasons; and purely empirical trials are not calculated to advance our knowledge on the subject, but can only lead to uncertainty.

On lighting carbon-filament lamps in an 8 per cent. mixture, traveling at a velocity of 40 in. per second, the committee stated that an ignition of the mixture occurred with the first lamp tried, and before the rupture of the filament; whilst with a stronger lamp seven ignitions were obtained in succession with the same filament. This indicates, as the authors have pointed out in the case of coal-gas mixtures, that ignition by simple incandescence may occur under certain favorable conditions. These conditions seems to have been almost attained by Stassart in his experiments; but not absolutely so, the third lamp tried (consuming 3.08 volts and 0.5 ampère) having burned for more than three minutes without producing an explosion. With the Arras lamp the authors found that the filament, though giving a brilliant light *in vacuo*, merely threw out a faint glow after the lamp was opened, and broke at the centre in a few minutes, without inducing an explosion. Similar negative results were obtained with five lamps; but on the lamps being surcharged with current, even though slightly, an explosion almost inevitably occurs on the rupture of the filament.

In the other tests made by Stassart, with metal filaments, one lamp (consuming 4.1 volts and 0.38 ampère) gave ignition immediately, but when tested again did not ignite the mixture until the filament broke. With an osmium lamp (1.8 volts and 1 ampère), owing to the low resistance, a first ignition was again obtained, but could not be repeated. The ampèrage was found to have diminished, no doubt in consequence of the filament becoming thinner as a result of gradual combustion, the resistance being thereby increased, as was observed in the tests carried out by the authors with strong lamps.

The question amounts to this, that firedamp mixtures are exploded either by the spark or by the incandescence of the filaments. The disruption spark, though infinitely more effective than incandescence, does not invariably produce ignition; and the authors believe they have established the main cause of the divergent effect produced by different sparks, namely, in the ratio between the resistance of the source of current and the resistance of the filament—the greater the resistance of the generating apparatus, the greater the igniting power of the disruption spark, even when the latter is small in volume. In the extremely large number of experiments carried out by the authors, they only succeeded in producing ignition when the filaments were of platinum wire below 0.2 mm. in diameter. The closed 10-candle lamps charged with a 9.5 per cent. mixture gave no ignition, even under a surcharge of voltage, except on the rupture of the filament, although it was expected, from previous experience, that an explosion would inevitably occur under such conditions.

SEARCHLIGHT SHELLS

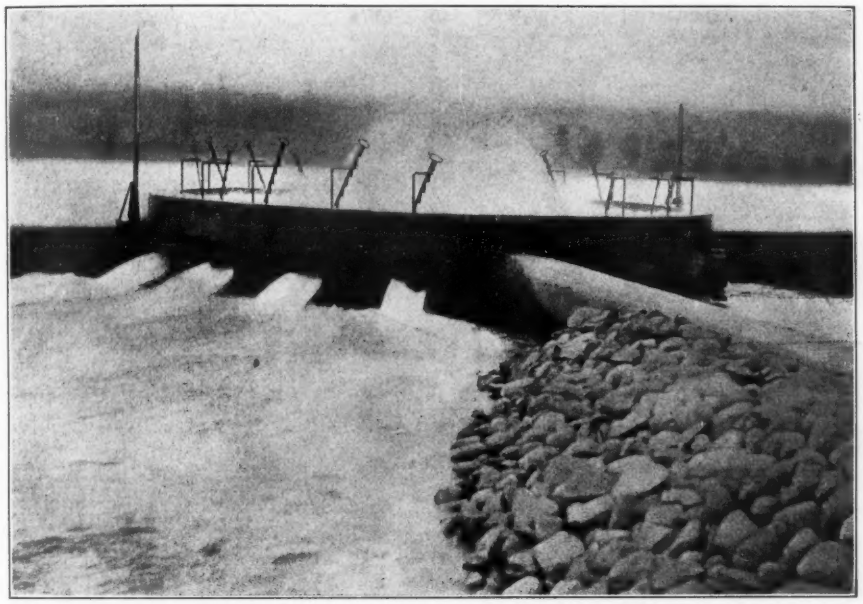
Acetylene shells, which are being experimented with in the German navy, have so far proved much more effective at long distances than ordinary searchlights in lighting up large areas of water. These shells are said to contain calcium-carbide, and are so made that the water can reach it through a tube. The shells can be thrown upwards of 10,000 yards, by a gun constructed specially for the purpose, and it is hoped to increase this distance by suggested modifications of the weapon.

On being fired the shell eventually pitches into the water, and, the water entering the tube, its action upon the calcium-carbide produces the acetylene light. Each shell is said to have 3,000 candle-powder, and it will burn for no less than three hours. One of the chief advantages of lighting up an enemy's position in this way, over that of using a searchlight, is that a searchlight indicates the position of the ship, and gives a definite target for return fire by the enemy. With acetylene shells fired from a gun, the ship will relapse into darkness and her enemy be lit up by a few well-placed lights from the acetylene gun. The possibilities of the use of such a means of lighting up the horizon around a fleet, for the detection of the presence of torpedo boats, are very large, and cannot be taken in at a single mental glance. As a matter of fact a battleship would be able to imitate the particular fish who emits a fluid which beclouds the water and conceals his own movements; for the ship could light up the horizon with powerful flares to blind and ex-

pose its opponents, and then move about in the dark inner circles to the points at which it could best deal with them with its ordinary armaments. That is what our friends the Germans are doing, and we must follow suit if we would be ready for them by the time they are ready for us with their new 21-inch Whitehead torpedo, with an effective range of 7,000 yards or upwards. We have the lead, and every effort must be made to keep it.—*United Service Gazette.*

A SCIENTIFIC ENIGMA

Carbon, represented as it is in the form of graphite, the diamond, charcoal, coal, lampblack, etc., has about it an impenetrable mystery. According to Professor Larkin of California, it is archaic and eternal, omnipresent and primordial. The spectroscope, that marvel of all ages, shows carbon glowing in the sun at white heat, and we know that it burns —that is, unites with oxygen in our bodies—



AERATOR OF SPRINGFIELD WATER WORKS.

A LARGE WATER AERATOR

The half-tone on this page, from a paper before the New England Water Works Association, by Mr. Carroll F. Story, shows in operation the aerator which is an important element in the water purification system of Springfield, Mass. The aerator is located where the corners of four rectangular filter beds come together. There is a concrete basin 30 feet in diameter and the water is aerated by overflowing from the elevated end of a 30 inch vertical discarge pipe. The water is raised from the reservoir into the aerator by a 20,000,000 gallon centrifugal pump. Sixteen outlets from the basin, each furnished with a gate, provide for the discharge of the water into either of the filters as desired.

thus keeping us alive by the evolution of heat. Carbon is the concentrated life of nature.

You can get equal quantities of carbon for one cent or for one million dollars. To strike up a bargain it would seem that the investment of one cent would be the wisest. You can obtain a piece of carbon in the form of graphite for one cent. You will find it as black as the ace of spades is said to be. It is not only jet black, but is smooth, soft and friable.

If you want the same weight of pure white carbon, it may be had in the shape of a diamond for a million or two. In this shape the carbon is the hardest body known, and the most difficult to melt, yet electricity is able even to make diamonds liquid.

Therefore, carbon is found pure in the dia-

mond, nearly or quite pure in graphite, which is the material in our lead pencils, and for some inscrutable reason is it called "lead." Carbon is also found in charcoal, coal, coke and petroleum.

All animals and plants contain carbon in their tissues; it is in the air, in the earth and is found in comets.

The carbon in the comet is not free, but is joined chemically to hydrogen in a body called a hydrocarbon. The comet comes to us from the appalling depths of space on a visit to the solar system. It comes to us and then goes away, frequently never to return, but the question is where did it get its carbon, for the spectrum of a comet shows light like that emitted by common gas, which is known to be carbon and hydrogen.

Hydrogen is always present in the most primitive forms of nebulae in space, and in the latest sun. Hydrogen is ever present near the "beginning" of cosmic evolution, and has a strong affinity for carbon, with which it combines in many proportions.

Meteors, also from the depths of space, bring carbon to the earth and sun. Those that reach the earth have in several instances contained carbon in the shape of diamonds, not very popular, however, because black, but good enough to cut glass with.

Of all conceptions that can fill the mind with sublime thoughts, the white hot liquid carbon envelop of the sun is the most impressive.—*Graphite.*

Most everyone familiar with the use of peroxide of sodium knows that coming in contact with moisture it will generate intense heat and if it has anything inflammable to work on will "start something." A young man working for a Chicago firm mastered all the ingredients of a desired formula but one. This one (a powder) he took a small amount of in a piece of paper and puts it in his hip pocket. The day being warm, he was in a profuse perspiration. It did not take long for the moisture from his body to get action on the peroxide of sodium and there was "something doing" at once. A broken plate glass window was no bar to the hurried progress of the young man in his endeavor to reach safety, but the glass cut some figure in the expense of his experiment.—*National Laundry Journal.*

TESTS UPON COMPRESSED AIR PUMPING SYSTEMS OF OIL WELLS

By Edmund M. Ivens.

When the Louisiana oil fields at Evangeline were in full operation, they offered exceptional opportunities for the study of air lifts. Nearly every known method of piping the wells was in use. The air plants originally installed were the crudest affairs imaginable, having been erected in feverish haste during the boom several years ago. When the production of the fields began to decrease, and the price of oil also declined, it was realized for the first time that the operating expenses were abnormal, and that unless greater economy were practiced, disastrous results would follow.

Each concern has a central station or air plant and all the compressors therein are connected to a manifold from which the air lines lead to the various wells on the property. Oiter the air lines reach the wells by a roundabout way, and have innumerable short bends, valves, double swings to avoid pipe cutting, and plugged tees instead of elbows. The size pipe used for these air lines is designed neither for the amount of air to be transmitted nor for the distance it is to be carried, but is with one exception 2 in. in diameter. The boilers of the air plants are of 40 h.p., of a portable, contracted waist type, and few were covered with asbestos. The boilers were so set that one-fifth of their lengths projected into the open.

The redeeming feature in all the plants is the type of compressor in general use. These compressors are generally of high grade, and display remarkable endurance. It is common for a machine designed for 350-lb. pressure to operate under a pressure of 500 lb., and at speeds far in excess of those for which it was designed. The most popular type of compressor has the duplex steam end and compound or two-stage air end. The steam cylinders are fitted with Meyer adjustable cut-off valves and the air cylinders in some instances with piston-inlet and in others with Corliss intake valves and poppet discharge valves. Plain speed governors are used and the capacities of the compressors range from 100 to

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*Presented at the Spring Meeting of The American Society of Mechanical Engineers. (Abridged.)

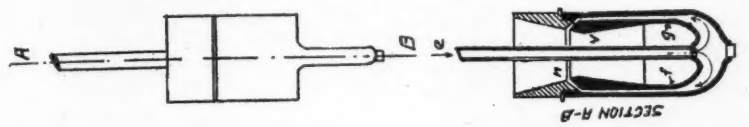


FIG. 4 SYSTEM COMBINING FEATURES OF OTHER SYSTEMS DESCRIBED

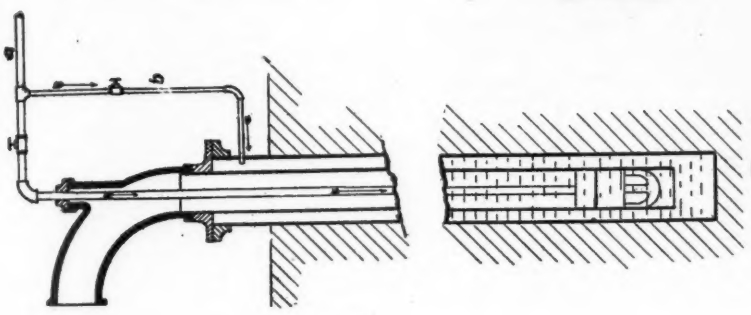


FIG. 3 RETURN BEND SYSTEM

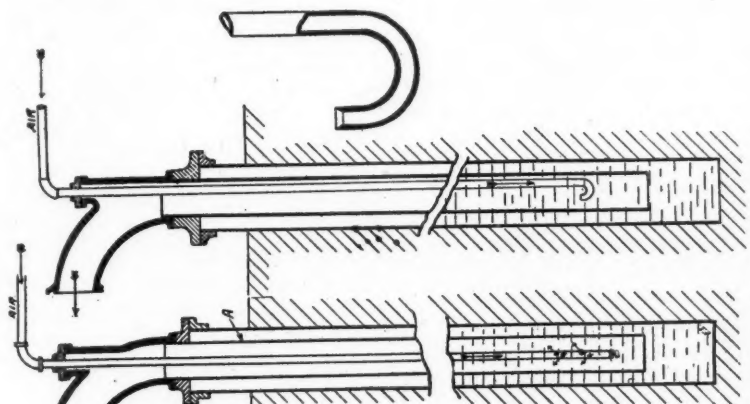


FIG. 2 CENTRAL PIPE SYSTEM.

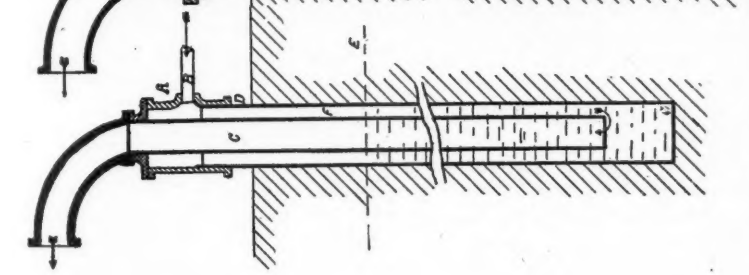


FIG. 1 STRAIGHT AIR LIFT SYSTEM

1,000 cu. ft. of free air per minute and operate at pressures of from 150 to 750 lb. per square inch. The machine best adapted to the purpose, however, is the 500 cu. ft., 500-lb. type.

TERMS.

"Submergence in feet" refers to the number of feet below the surface of the fluid (after the well has been pumped down, and is operating under its normal conditions) that the air under pressure is admitted. "Per cent. of submergence" is the submergence in feet divided by the total number of feet of vertical discharge line, measured from the point of admission of the air to the point of discharge of the fluid. "Volumetric efficiency" of the compressor is the actual amount of free air that is compressed and discharged by the cylinder, divided by the cubical contents [actual piston displacement] of the cylinder. "Free air" is air at normal temperature and pressure. "Pumping head" is the vertical distance in

feet (after the well is pumped down) from the fluid level in the well to the point of discharge.

$$\text{"The Constant"} = \frac{\text{Gal. per minute} \times \text{pumping head in feet}}{\text{Cu. ft. of free air per minute}}$$

$$\text{"The Ratio"} = \frac{\text{Cu. ft. of free air per minute}}{\text{Cu. ft. of fluid per minute}}$$

DESCRIPTION OF SYSTEMS.

Figs. 1, 2, 3 and 4, illustrate the air lift systems that are and have been in use on the oil fields.

Fig. 1 shows the Straight Air or Saunders system. The well top is sealed as shown at A. Compressed air is forced through the pipe B into the space between the discharge or eduction pipe C, and the well casing D. When without air pressure the fluid in the well will stand at some point such as E, the level in the air space and the discharge line being identical. When air is forced through B, the level of the fluid in the air space is gradually forced down until the end of C is uncovered. Instantly some of the air escapes into the discharge pipe C, lowering the air pressure in the air space F. This causes the fluid to rise in and up the air space and discharge pipe until a point is reached where air and water pressure balance. Then, more air coming in, the pressure again rises, the fluid level is forced down as before, more air escapes into the discharge pipe, and thus the cycle is repeated. As may be readily seen, the air that rushes into the discharge line carries the "slug" of water that has just previously entered.

Fig. 2 shows what is commonly known as the Central Pipe system. The discharge line A is placed inside of the well casing as before, and inside of the discharge is suspended a small air line usually 1¼ in. in diameter. The end of the 1¼ in. line is plugged and a number of ⅛ in. holes are drilled inclining upwards in the last joint of pipe. Air is forced down through the small air line shown, passes out of the ⅛-in. holes, and mingles with the fluid, carrying it out through the discharge line A. It is generally supposed that the fluid in this case is discharged because of the aëration of the fluid in the discharge pipe, which in turn is caused by the intimate commingling of air and fluid. The weight of the fluid column inside of the discharge pipe is therefore less in pounds per square inch than that without and the energy due to this difference in weight is utilized to lift the fluid and overcome the various losses.

What is commonly known as the Open End system of air lift was at one time in quite extensive use on the field. It is similar to the system just described except that the small air line is open at the lower end, and of course there are no holes drilled in the air line.

Fig. 3 illustrates a form of the Return Bend system. It is claimed by the inventor that: "It consists in improved processes and apparatus whereby the compressed air is delivered in bulk into the lower end of the water eduction pipe, and the water and air are caused to ascend through said pipe in distinct alternate layers of definite dimensions."

Fig. 4 shows a patent system which in reality is a combination of the several systems already described. The claims of the inventor are: less submergence, and hence less air pressure necessary, decreased air consumption, or, with an equal amount of air, increased fluid yield.

Compressed air is forced through *a* down into the foot piece, which is placed at that point of submergence shown by test to be most economical. The well top is sealed and air under pressure is also admitted between the casing and discharge pipe on the water head by means of the branch shown at *b*. This forces the fluid to a higher level in the discharge pipe and also prevents fluid in the air space or chamber from vibrating and foaming. This is quite an advantage in oil well pumping, as the liability of making "riley oil" is thereby greatly lessened.

The footpiece shown in section is made of cast brass and is in two parts. The air on reaching the footpiece divides and goes up through the hollow prongs *f* and *g* and out the nozzle *n*. The nozzle is adjusted to receive the quantity of air to be used by screwing the upper part *s* of the footpiece, in or out as the case may be. To increase the velocity of the fluid in the discharge line, the footpiece is restricted and formed into a "venturi" as shown at *v*.

TEST NO. I.

The Crowley Oil and Mineral Company was the first to take active steps for the improvement of their plant and pumping equipment.

They decided to install the patent air lift last described (Fig. 4). A test of the old system was first made to determine the amount of compressed air used and the fluid yield. The new equipment was next installed and a similar test made of the same duration and under the same conditions. The tests and installation were conducted on Well No. 32, 1,805 ft. deep, and located 542 ft. from the compressor operating it. The air to the well was controlled by means of a manifold in the plant and was conveyed to the well top through a two-in. pipe line which as usual was in poor condition and badly designed.

The system of pumping was that illustrated in Fig. 1. The well casing was 6 in. in diameter, suspended inside of which was a 4-in. discharge line.

The compressor was a duplex steam and compound air type, made by the Ingersoll-Rand Company and designed to compress 1,000 cu. ft. of free air per minute to 350 lb. pressure. The steam end was fitted with Meyer adjustable cut-off valves and the air end with Corliss intake and poppet discharge valves.

The discharge pipe from the well top was run up into a steel tank of known dimensions

TABLE 1 SUMMARY OF RESULTS

THE CROWLEY OIL AND MINERAL COMPANY, EVANGELINE, LA.

	Old System	New System
Duration of test, hours	5.5	6.0
Mean i.h.p.	122.56	89.19
Mean water h.p.	9.97	10.36
Mean air h.p.	107.38	79.16
Gallons of fluid per second	0.542	0.608
" " " " hour	1953.6	2188.2
Barrels of fluid per hour	46.51	52.1
Weight of 1 gal. of fluid	8.7	8.69
Mean temperature of fluid, deg. fahr.	111.5	113.2
Percentage of salt water in fluid	87.3	86.7
" " sand "	2.2	1.9
" " crude oil "	10.5	11.4
Barrels of oil per hour	4.86	5.94
Barometer reading, inches of mercury	29.95	29.94
Specific gravity of oil	0.9	0.9
Constant	63.1	101.8
Size of air line, inches		1.25
Total depth of well, feet	1805.0	1805.0
Size of casing, inches	6.0	6.0
Height above ground to which the fluid was pumped, feet	18.5	18.5
Size of discharge line used, inches	4	4
Total length of vertical discharge line	1513.5	1513.5
Total length of vertical air line in well	1513.5	1493.0
Dimensions of compressors, inches	10x22x16x20	7½x18x16x20
Number operated	1	1
Kind of fuel used	Crude oil	Crude oil
Gallons of fuel used per hour	48.36	35.27
Barrels of fuel used per hour	1.15	0.835
Price of 1 bbl. of oil at time of test, dollars	0.90	0.90
Cost of fuel for producing 1 bbl. of fluid, dollars	0.0222	0.0146
Cost of fuel for producing 1 bbl. of crude oil, dollars	0.212	0.126

and the amount of fluid pumped during the test ascertained by direct measurement. Air gages were placed both at the compressor and at the well top, thereby making it possible to determine the friction losses in the manifold and air line and also the actual pressure at the well top. Simultaneous indicator cards were taken from the steam and air ends of the compressor, and from these cards were obtained the volumetric and mechanical efficiencies, the steam and air horse powers, and the steam consumption (theoretical) of the machine.

When these tests were run, no attempt was made by the writer to re-design the air lines, or to correct in any manner the numerous other defects. The old system was tested just as it had been operated, and the new system was installed and tested under the same ad-

TABLE 2 SUMMARY OF RESULTS

WELLS NO. 12, 30, 32, CROWLEY OIL AND MINERAL COMPANY

Duration of tests, hours	6.0
Mean (total) i.h.p.	151.1
" " w.h.p.	25.14
" " a.h.p.	129.05
Total gallons of fluid per hour	6168.0
" barrels " " " "	146.87
" " " oil " "	16.17

WELL NO. 12

Weight of 1 gal. of fluid	8.5
Temperature of fluid	118.5
Per cent of salt water in fluid	87.2
" " " sand " "	1.3
" " " crude oil " "	11.5
Barrels of oil per hour	6.44
Specific gravity of oil	0.87
Total depth of well in feet	1705.00
Size of casing, inches	6.00
" " discharge line, inches	4.00

WELL NO. 30

Height above ground to which fluid was pumped, feet	17.5
Total length of vertical discharge line	1025.5
" " " " air line	992.58
Weight of 1 gal. of fluid	8.65
Temperature of fluid	120.2
Per cent of salt water in fluid	88.3
" " " sand " "	1.5
" " " crude oil " "	10.2
Barrels of oil per hour	4.83
Specific gravity	0.9
Total depth of well in feet	1920.00
Size of casing, inches	6.00
" " discharge line, inches	4.00
Height above ground to which fluid was pumped, feet	18.00
Total length of vertical discharge line	1516.3
Total length of vertical air line in well	1494.2

WELL NO. 32

Weight of 1 gal. of fluid, pounds	8.7
Temperature of fluid	114.5
Per cent salt water in fluid	86.9
" " sand " "	1.8
" " crude oil " "	11.3
Barrels of oil per hour	4.90
Specific gravity	0.9
Total depth of well, feet	1901.00
Size of casing, inches	6.00
" " discharge "	4.00
Height above ground to which fluid was pumped	18.5
Total length of vertical discharge line	1513.0
Total length of vertical air line in well	1493.0
Size of air lines in wells, inches	1.25
Barometer reading, inches of mercury	29.95
Dimensions of compressor, inches	10x22x16x20
Number operated	1
Kind of fuel used	Crude oil
Barrels of fuel used per hour	1.45
Price of 1 bbl. of oil at time of test, dollars	0.90

verse conditions. After both systems had been tested, some few of the defects were corrected in the manifold and air line design, thereby insuring more economical operation in the future.

TEST NO. 2.

WELLS NO. 12, 30 AND 32 OF THE CROWLEY OIL AND MINERAL COMPANY.

The saving in air volume accomplished by the new system led those interested to endeavor to operate two wells with one machine, something before considered impossible in the field.

Well No. 30 was forthwith tested, though not with sufficient accuracy to warrant the publication of the results, and the approximate pumping head and submergence established The new system was then installed with the requisite pipe to equalize the submergence (hence working pressure) of this well with that of No. 32.

The two wells in question were then connected to one air compressor with gratifying results. No trouble was experienced in starting, and the machine furnished air in abundance for steady operation.

Preparations were being made to run the usual test when the compressor operating Well No. 12 "went dead." This last named well had been previously tested and equipped with the new system. This shutdown, of course, would mean a loss of at least a day's production from the well, amounting to quite an item, so the writer advised that this well also be connected to the machine already operating No. 30 and No. 32. By speeding the machine up a few revolutions, the additional load was easily taken care of as may be more fully noted by reference to the accompanying log (Table 2).

TEST NO. 3.

MILL HILL NO. 2, MAMOU POWER COMPANY.

This test was run in the same manner as those preceding except that the fluid field was ascertained by means of a two-foot rectangular weir placed between the earthen fluid and oil pits, the salt water bleeds of the former having been closed. The old system used was that illustrated in Fig. 2.

The depth of fluid over the crest of the weir was measured by means of the ordinary hook gage calibrated to read accurately in hundredths of a centimeter. The weir constant

TABLE 3 SUMMARY OF RESULTS

WELL NO. 2, MAMOU POWER COMPANY

	Old System	New System
Duration of tests, hours	10.0	10.0
Mean i.h.p.	99.1	62.8
" w.h.p	9.85	13.36
" a.h.p	82.5	50.4
Gallons of fluid per second	0.694	0.849
" " " " hour	2499.6	3056.4
Barrels of fluid per hour	54.75	72.77
Weight of 1 gal. of fluid, pounds	8.72	8.75
Mean temperature of fluid, deg. fahr.	118.3	117.9
Percentage of salt water in fluid	87.7	86.1
" " sand " "	1.2	1.6
" " crude oil in fluid	11.1	12.3
Barrels of oil per hour	6.08	8.95
Specific gravity of oil	0.9	0.9
Barometer reading, inches of mercury	29.94	29.93
Weir constant	24.39	24.39
Pumping constant	97.1	202.9
Total depth of well in feet	1901.0	1901.0
Size of casing, inches	6.0	6.0
Height above ground to which fluid was pumped, feet	3.33	3.33
Size of discharge line used, inches	4.0	4.0
Size of air line in well, inches		1.25
Total length of vertical discharge line	1500.0	1500.0
Total length of air line in well	1489.5	1489.5
Dimensions of compressor, inches	$7\frac{1}{2}$x18x16x16	$7\frac{1}{2}$x18x16x16
Number operated	1	1
Kind of fuel used	Crude oil	Crude oil
Gallons of fuel used per hour	44.22	30.53
Barrels of fuel " " "	1.05	0.727
Price of 1 bbl. of oil at time of test, dollars	0.85	0.85
Cost in fuel of producing 1 bbl. of fluid, dollars	0.0163	0.0085
Cost in fuel of producing 1 bbl. of crude oil, dollars	0.128	0.069

was previously determined by testing in the usual way, using a sample of the fluid as pumped from the well.

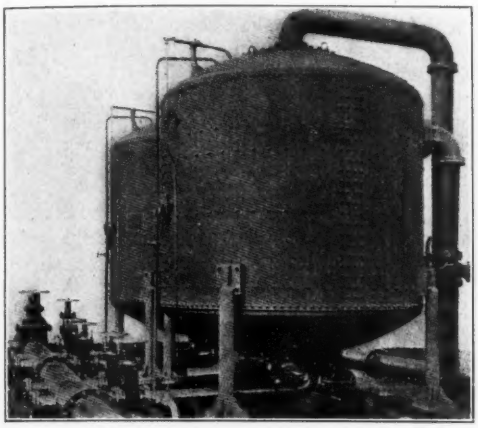
At the University of Wisconsin recently one hundred and fifty city engineers, general managers of power and traction companies, contracting engineers, superintendents of water and light plants, mechanical and civil engineers and superintendents of highway construction organized the Engineering Society of Wisconsin. The officers elected were: President, F. E. Turneaure; vice-president, McClelland Dodge; trustees, B. F. Lyons, E. P. Worden, E. Gonzenbach and E. R. Banks.

A COMPRESSED AIR OXYDIZING FILTER

The following description of the Candy compressed air oxydizing filter we abstract from a paper by Mr. John Don before the Institution (British) of Mechanical Engineers. Candy is of course the name of the inventor of the filter.

Against the use of coagulants their have been urged various objections, some rather fanciful, others more real. There is the question of expenditure, representing an outlay of $1.25 to $2.50 per million gallons filtered ($1.50, on the average, per grain per gallon per million gallons). It is to be recognized

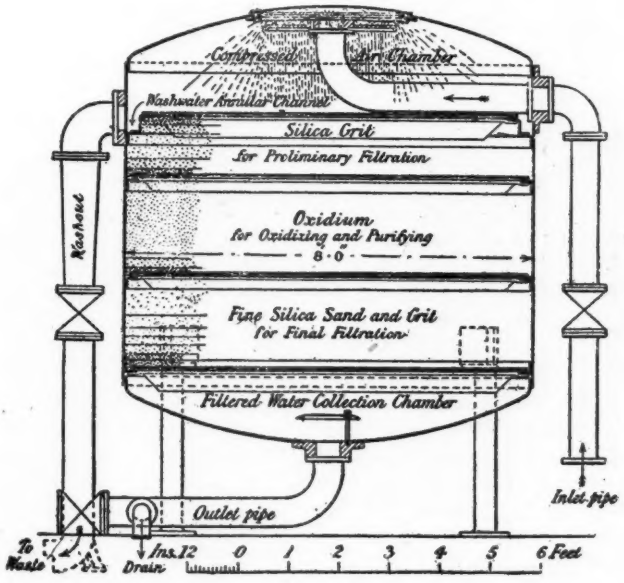
also that it may be beyond the capacity of the ordinary attendant of a filtering plant to determine the exact amount of coagulant which should be added under varying conditions of the raw water.



CANDY COMPRESSED AIR AND OXYDIZING FILTER.

Oxidium, which is the effective medium of the Candy filter, is a porous composition of iron oxide, silica, etc., which exhibits properties similar to those of spongy platinum. Consisting largely of iron and silicates, oxidium absorbs oxygen from the air and yields it again to organic matters suspended or dissolved in the water under filtration. Living germs are intercepted as efficiently as in any of the filters described in the paper. It appears that wet combustion proceeds rapidly as the water percolates. The oxygen is supplied from the pores of the oxidium, wherein it is occluded. The stored oxygen is gradually used up as filtering goes on, but it is easily renewed by emptying the cylinder and admitting air. By a simple means a large volume of air is compressed into the dome of the cylinder, so that the descending water is well aerated.

Dr. Thresh has made many analyses of the effluents of the Candy filters, and the purification in general has been shown to be admirable. Practically speaking, there is no escape for pathogenic bacteria. Albumenoid ammonia is reduced to an insignificant amount. Nitrification makes great progress in passing through the layers of oxidium. Iron salts in solution are wholly got rid of. These are conclusions which may be drawn from Dr. Thresh's investigations.



SECTION OF CANDY FILTER.

THE MEASUREMENT OF COMPRESSED AIR

Before the Transvaal Institute of Mechanical Engineers, recently, Professor Orr read an important paper on "The Measurement of Compressed Air and How the Problem Affects Stope Drills and Central Compressed Air Stations." Professor Orr pointed out that an added importance had been given to the subject owing to the initiation of the Transvaal Stope Drill Competition, in which the air consumption was going to constitute an item of some weight, and, further, to the recent decision to establish a huge central compressed air station in connection with the mines. The distribution of air from central stations was by no means new, but the measurement of the air has always been a question of considerable difficulty. The air consumption of rock drills had been a matter frequently referred to at the Institute, but the measurement had on each occasion been based on the readings of a meter intended to measure water. Taking the ordinary types of water meters, as used for distribution, they might be divided into: (a) Inferential meters; (b) volume or capacity meters; (c) displacement meters. No doubt any water meter could be used as a compressed air measurer, but in the majority of cases calibration by passing known weights of air at constant pressure through them would be necessary. Professor Orr stated that he had in the College Laboratory twelve examples of water meters, but so far the only one which had been thoroughly tested was the displacement meter made by Kennedy, and which had been the type used in previous rock drill tests on these fields.—*South African Mining Journal.*

CANDLE-POWER UNSATISFACTORY AS A GAS STANDARD

The annual report (1908) of the Public Service Commission of the second district of New York says:

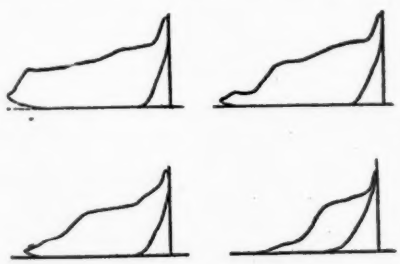
The employment of the candle-power standard in this state in determining the value of gas is subject to fair criticism. When gas was used solely as an illuminant, and by means of open-flame burners, its value was properly measured in terms of another illuminant, the candle, as a standard. In recent years, incandescent mantles have largely displaced the open-flame burners. The light given off from this device is generated by raising the mantles to a high temperature. In recent years also gas has come into existence as a fuel. Under these conditions, a very small percentage, probably in this state less than 20 per cent. of the total gas consumed, is now used in open-flame burners.

As the measure of the value of gas should be based upon the preponderance of purposes for which the gas is used, the candlepower as a standard apparently has come to be of minor importance.

For the purpose of confirming this, the commission has begun a systematic series of tests which will determine the heating properties of gas as now supplied under candle-power restrictions, and whether the establishing of the heating value as a standard will not result in giving a more satisfactory service than the commonly used candle power standard.

CARDS FROM AN ADJUSTABLE CUT-OFF ROCK DRILL

The indicator cards herewith, which we reproduce from the *Pacific Miner,* are from an air operated rock drill made by the Mitchell Machinery Company, Denver. The drill cylinder is 2¾ in. diameter, 4 in. stroke, with "17 pound hammer," the latter, we assume, being the weight of piston and chuck, with presumably also the steel. The drill is provided with a cut-off which can be adjusted through its entire range without stopping the drill. The cards were taken at ⅞, ⅝, ½ and ¼ cut-off respectively, and with due allowance for the difficult conditions, should be considered excellent. In operating a rock drill the imperative thing is not the production of ideal cards or the securing of minute economies in air consumption, but rather the striking of the ideal blow into the rock and the greatest economy of time in rock penetrations. Of this the cards give no evidence either way.



COST OF THE BIG CUNARDERS

These magnificent boats—the finest steamers afloat, the best creation of modern nautical skill and ability—were practically donated to the Cunard Line. Nothing has been spared to make them perfect; nothing has been spared which could render them more swift, more strong, more true, more useful. Nothing has been spared to secure economy of administration, of maintenance, and of operation. These magnificent vessels cost $6,500,000 each. The English Government loaned the money to the Cunard Line—to the company—under terms, and in accordance with agreement, whereby the subsidies paid by the Government meet every payment of interest and principal the moment it becomes due. At the end of twenty years the *Mauretania* and the *Lusitania* will not have cost the Cunard Company one cent. All the Cunard Company has had to do, all the Cunard Company will have to do, is to make a profit over and above the cost of maintenance and operation.—*Speech in Congress of Hon. J. Sloat Fassett.*

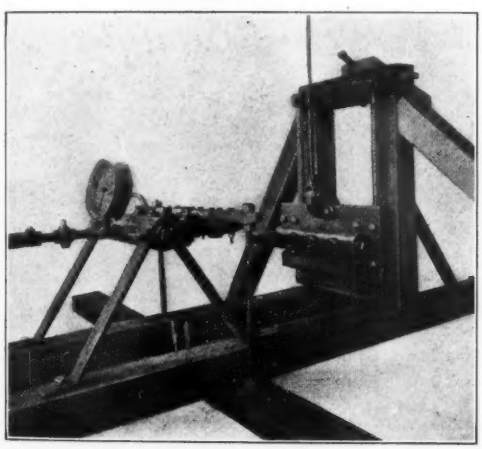


FIG. I.

A HOSE FATIGUE TESTING MACHINE

When the testing of air brake hose is spoken of the first thought naturally is that a pressure test, with an ample factor of safety, is all that could be required. Practice, however, shows that such a test is not sufficient, since hose gives out generally not as the result of dead pressure, but on account of the constant bending to which it is subject on rapidly moving trains. The half-tone Fig. 1 reproduced from the *American Machinist,* shows an apparatus in use in an English shop for testing samples of hose simultaneously both for pressure and for constant bending and kinking. The hose is first tested with water up to 600 lbs., and then samples 20 inches long are attached at one end to the fixed manifold shown and the other to the manifold on the vertically moving crosshead. This crosshead is connected by the rod to a crank overhead and has a travel of 14 inches, making 40 double strokes per minute. The pressure on the hose is kept constantly at 90 lbs.; most samples last 25 hours, while some run as long as 40 hours. The severe kinking which occurs is suggested in Fig. 2.

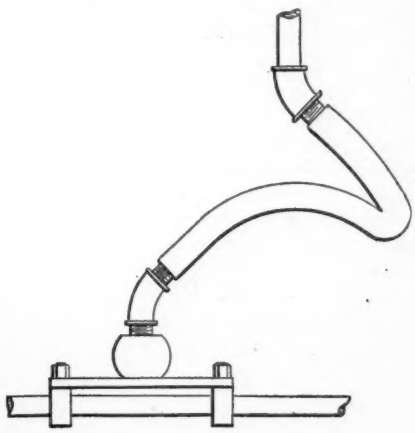


FIG. II.

WATER PUMPED BY ITS OWN GAS

A system of separating natural gas from water is being used to pump water from a large flowing well between Redono and San Pedro, Cal. The well yields a heavy stream of water with much natural gas running through it, and it is this gas which is being transformed into power to drive the engine. The gas and water are separated in a large iron tank, which at its trial sent a considerable volume of gas into the air, while 1,000 gallons per minute of pure water was carried to the reservoir. The gas is carried to the engine by suction. The device is expected to render waste lands productive and add much value to tracts which hitherto have not been irrigated on account of the great quantity of marsh gas in the water strata.

HYGIENIC ECONOMICS

In Bulletin No. 79, of the Bureau of Labor, Frederick L. Hoffman, discusses processes and working conditions in occupations where, because of dust, the employment is injurious to health and leads in particular to the development of consumption.

It is the opinion of the author that by intelligent methods of ventilation and dust removal the consumption death rate among wage-earners can be reduced from 2.2 per 1,000, the rate based on the number of deaths among gainfully employed persons 10 years of age and over in the registration States in 1900, to 1.5 per 1,000, the average rate for 200 small cities, as shown in the mortality statistics of the United States Census for 1901 to 1905. Such a reduction, the author estimates, would result in an annual saving of 22,238 human lives and would add 15.4 years of life for every death from consumption avoided by rational conditions of industrial life. Such a gain would represent a total of 342,465 years of additional lifetime, and by just so much the industrial efficiency of the American nation would be increased. Placing the economic value of a year's lifetime at only $200, the total average economic gain to the nation would be $3,080 for every avoidable death of a wage-earner from consumption, representing the enormous total of $68,493,000 as the aggregate annual financial value in the probable saving in years of adult human life. With such results clearly within the range of practical attainment, nothing within reason should be left undone as a national, state, and individual or social duty to prevent that needless, but now enormous, loss of human life from consumption due to the unfavorable conditions in American industry.

CLEANING BRIDGE STEEL WITH SAND-BLAST

A sand-blast apparatus operated by a compressor driven by a gas engine, was used some time ago in cleaning the bridge across the Mississippi River at Fort Madison, Ia., preparatory to painting it for the first time in 12 years. The total length of the structure is about three-quarters of a mile. The air plant was located on a spur near the western end of the bridge and consisted of a 45-hp. multiplex Otto gasoline engine, an air compressor, a 5x15-ft. receiver, water tank for cooling water, and a gasoline tank. In order to start the large engine a 2-hp. simple Otto gasoline engine was used to raise the pressure in the receiver to 75 or 80 lb., the large engine maintained a pressure of 85 to 100 lb., depending on the number of blasts in operation. The air was taken onto the bridge from the receiver through 1½-in. pipes tapped and plugged every 60 ft. for attachment to the sand drums. The latter were of steel with hemispherical bottoms. The main air line branched at the drum into a large pipe leading into the drum, a ½-in. pipe for carrying the pipe from a vertical branch beneath the drum, and a ½-in. pipe connecting into the blast line beyond the latter point. Connection between the drum and the nozzle was made with ½-in. reinforced rubber hose, 50 ft. long. The nozzle was a ⅜-in. pipe reduced to a ¼-in. tip. The bridge was cleaned in three months, using three machines. —*Engineering Record.*

STEEL GAS MAINS

The improvements in the production of steel, and its application to the manufacture of solid drawn tubes by the Mannesmann process, leads to an increasing use of this material in place of cast iron for gas mains. The production of steel tubes up to 30 or 40 ft. in length, with the advantages of increased carrying capacity, fewer joints and flexibility, combined with the unbreakable nature of the material, coincides with the need that has arisen to resist the strains put upon pipes by the methods now adopted in the construction of road surfaces and the increased weight of traffic upon them; and these factors have contributed to shake the monopoly so long held by cast-iron pipes for the conveyance of gas and water. One great drawback to the use of light steel pipes for the purpose of distributing gas has been the difficulty of making a sound connection between the service pipe and the main; but improvements have recently been made which promise to remove this trouble. The British Mannesmann Company have introduced a method to accomplish this. By the insertion of strips of metal they increase the gauge on two sides of the tube, resulting in the thickening of the material in the position usually selected for the insertion of the service pipe, sufficient to provide thickness for the number of screw threads requisite to secure a sound joint.

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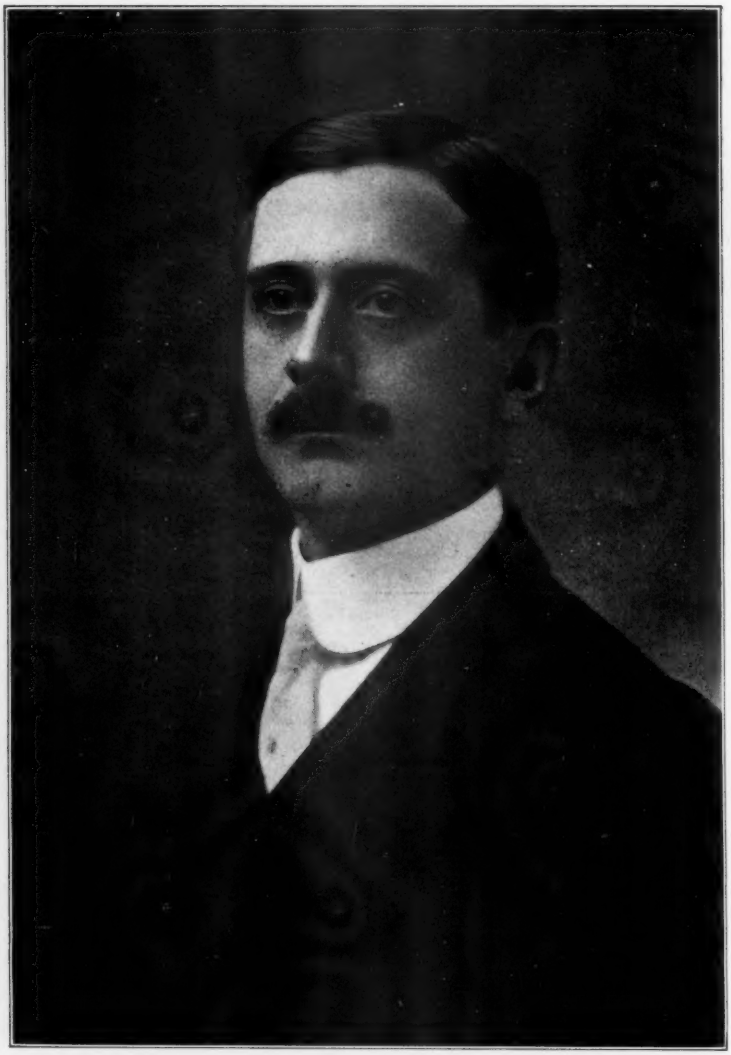
CHARLES T. PORTER

The John Fritz Medal is awarded annually "for notable scientific or industrial achievement." The recipients thus far have been: Lord Kelvin, George Westinghouse, Alexander Graham Bell, Thomas Alva Edison, and now Charles Talbot Porter. The award has been eminently well bestowed in each instance, and, speaking with careful weighing of words, the latest of the recipients of the medal is in no way less entitled to it than any of his illustrious predecessors. The general public knows less of Mr. Porter than of the others, but the engineering world knows him well, although few even here realize the magnitude of their indebtedness to him. The formal award in his case is for his work in the development of the modern high speed engine. He revolutionized steam engineering, and all the later developments of the power house and the special applications of steam in the rolling mill, in marine service, in the vast electric field, and practically wherever steam is employed, were led up to and made possible by him. And all this came not as the result of a single happy thought or of one great invention, but from a changing and adapting and originating of many details, so that in his life work the inventive faculty was constantly alert and resourceful. Not only was the designing and inventing task most exacting, but the high speed requirements created a revolution also in shop practice, and Mr. Porter became a pioneer in precise workmanship as it is known today, not only insisting upon minute accuracy and finish but devising also the ways and the means for such production. While the modern precise methods of manufacture and the almost absolute identity of parts produced cannot be credited to any one or even a dozen men, Mr. Porter was among the first and most insistent and successful of modern manufacturers, and in his line no more excellent workmanship has ever been achieved. Mr. Porter not only thus taught the tricks of high speed and precision, but he stimulated others to notable engineering achievements, and he was just in awarding credit. In the Porter-Allen engine he never allowed the Allen element to be overlooked or belittled. He stimulated Chas. B. Richards to produce the high speed indicator, and his book in exposition of it marked an epoch in the profession. All this work brought no wealth, nor even a retiring competence.



JASPER R. RAND.

Jasper R. Rand, president of the Rendrock Powder Company and vice president and director of the Ingersoll-Rand Company, died of pneumonia at Salt Lake City, March 30. He was the son of Jasper Raymond Rand of the powder firm of Laflin & Rand and one of the founders of the Rand Drill Company, and nephew of Addison Rand whose life work was in the presidency of that company.

Mr. Rand was born in Montclair, N. J., Sept. 3, 1874, and was graduated from Cornell University in 1898 with the degree of Mechanical Engineer, and the Spanish American War occurring just at that time he saw service in Porto Rico as a member of the First New York Volunteer Engineers. Immediately following that experience, 1899-1900, he was president of the Imperial Engine Company, Painlat Past, N. Y. From 1900 to 1905 he was president of the Rand Drill Company and since

1905 he had been vice president and director of the Ingersoll-Rand Company, this continuing his principal business interest. Besides his presidency of the Rendrock Powder Company, he was connected with the Locke Steel Belt Company and various Western mining operations.

Mr. Rand was a member of the Alpha Delta Phi fraternity, of the Spanish War Veterans, the American Institute of Mining Engineers, American Society of Mechanical Engineers and of the Knollwood, Army and Navy, Alpha Delta Phi and Cornell Clubs, also the Automobile Club of America. His only near surviving relative is a married sister, traveling abroad.

MAJOR ZALINSKI

Major Edmund L. Zalinski, U. S. Army, retired, died at the New York Hospital March 10. He was best known, especially to our readers, as the inventor of the dynamite gun. He was born in Poland in 1849, coming to this country with his parents when four years old, his boyhood being passed in Central New York. From the Syracuse high school he went into the Civil War in his fifteenth year, serving as an aide under Gen. Nelson A. Miles and being mustered out after a year's service as second lieutenant of volunteers. In 1866 he was appointed second lieutenant in the regular army, was first lieutenant in 1867 and captain in 1887, being retired for disability in 1894 and ten years later receiving the rank of major for civil war service.

Zalinski was Professor of Military Science in the Mass. Inst. of Technology from 1872 to 1876, and was graduated from the Artillery School at Fortress Monroe and the Fort Totten School of Submarine Mining in 1880. He traveled under orders in Europe in 1889 and 1890 to obtain special military information.

Most of Major Zalinski's time and thought had been devoted to the pneumatic dynamite gun which, as installed on the special cruiser Vesuvius, was capable of throwing a projectile weighing 1,000 pounds charged with 500 pounds of high explosives. It has never been suggested that any other man could have accomplished more under the hampering conditions, but the device was never a practical success and later developments in the constitution and in the handling of explosives rendered a special gun superfluous. Zalinski invented, also, among other things, an intrenching tool, a ramrod bayonet, a telescopic sight for artillery and a system of range and position finding for seacoast artillery firing. Major Zalinski in recent years resided in New York, and he was a member of the Century, Union League, Lotus and Engineers' Clubs.

TRADE PUBLICATIONS

INSTRUCTIONS FOR THE USE OF THERMIT IN RAILROAD SHOPS, Goldschmidt Thermit Company, 36 pages 6x9 inches. This is a revised edition of "Shop Instructions for the Use of Thermit in Repair Work," and it treats the matter very completely both in text and illustrations.

The Sprague Electric Company, New York, is sending out an attractive fan catalogue for 1909. It contains both direct and alternating current fans for desk, wall, ceiling, floor and counter column uses. Special attention is called to the new direct current oscillating desk and bracket fan on account of its simplicity and durability, and also to the fact that the oscillator mechanism can readily be attached to Lundell non-oscillating fans of the 1909 type.

NOTES

The maximum temperature allowed by law in underground stopes in Victoria, Australia, is 83 deg. F.

It costs less than four per cent. more in heat units to make a pound of steam at 150 pounds than to make it at atmospheric pressure.

The older the mine the more dangerous it it, so far as explosions are concerned. This is especially true where mines penetrate the earth to a considerable depth, and it does not matter whether the coal is reached by drift, slope or shaft opening.

An optimist has been likened unto a tea kettle which whistles loudest when it is in hot water up to its neck.

Cost of power per horse-power year, developed electrically by turbine water-wheels, ranges from $6 to $23 at various Eastern plants. It is sold at $13 at Niagara; at Law-

rence, Massachusetts, it costs about $20, with a 1,000-hp. installation. The average cost of steam-power would not exceed 0.8c. per horse-power hour.

The Kaieteur fall in British Guiana is said to be five times as high as Niagara and almost twice as high as the Victoria falls of the Zambesi.

Dr. Carroll D. Wright, president of Clark College and once U. S. Commissioner of Labor, whose death occurred recently, was in the early stages of his business career a patent attorney, and secured for T. A. Edison his first patent, that for a vote recorder.

Recent experiments show that ⅓ oz. of coal dust per 35 cu. ft. of air will suffice for the production of an explosion. It was also found that it is more a question of fineness of the division of the dust than the weight, that causes a condition of great danger.

Record-breaking progress is being made at the Cripple Creek Deep Drainage Tunnel. Between March 1 and 17, 476 ft. was gained. The distance from the portal to the first heading is now 5,383 ft., and from the foot of the intermediate shaft a total of 1,552 ft. has been driven.

A company has been formed in New York to manufacture flying-machines so that they can be sold for seventy-five hundred dollars; but a "glider with a catapult for launching" is offered for six hundred dollars. The cheaper device may serve to develop customers for the full-fledged machines.

A wider investigation of the pneumatic fire-box door closer and the mechanical stoker should be made, because the steady increase in the size of power will in all probability necessitate the adoption of some such devices in the interests of economy and of the firemen. —*Report of Committee, Traveling Engineers' Association.*

What is declared will be the first town of exclusive concrete construction in the world is to be established at Metaline, Wash., in the heart of a lead mining district of the same name, 105 miles north of Spokane, by the Leigh Valley Cement Company, of Pennsylvania, which has immense cement deposits nearby.

W. L. Saunders, president of the Ingersoll-Rand Company has been appointed a member of a special committee of the Chamber of Commerce of the State of New York to prepare a report on the Panama Canal. The committee will probably review the findings of several engineers on the question of the merits of a sea level canal as against a lock canal, and will investigate the advantages of the canal to American commerce and benefits to be derived from the canal in the future.

News comes from Liverpool that Sir Oliver Lodge recently succeeded in completely clearing away for a radius of 60 feet a thick fog by means of electrical discharges. The Marine *Journal* states that the Lodge system consists of driving electricity into a fog-laden atmosphere at a very high voltage from a series of disks at the tops of poles. The current acts directly upon the constituents of the fog, the electric influence whirling these hither and thither, causing them gradually to fall to the ground.

David Matheson, whose home is in Tacoma, Wash., a contractor in active business, has, as the result of accident, neither hands nor feet. He has just completed a large contract for the C. M. & St. P. Railroad, the work being on the western foothills of the Cascade Mountains, where immense masses of rock were to be blasted and carried to fill deep ravines. He personally oversaw and directed the work of cutting roads and establishing camps, and for two and a half years the work was carried on under his direct supervision.

The Richmond, Fredericksburg & Potomac Railroad Co., which is now operating its gravel washing plant near Fredericksburg, Va., to secure a roadbed ballast without dust, has now laid about 15 miles of line with new ballast, which, according to an official statement, proves extremely satisfactory, as it not only entirely prevents dust, but presents a very attractive appearance.

The first attempt at pneumatic separation of ores appears to have been made about 1828, but without success, and very little more was

done until Krom brought out his air-jig in 1868; this found application in a few isolated cases, and from that time to the present machines for pneumatic separation have been brought out periodically, but none has yet secured for itself a permanent hold upon the art of ore-dressing.

Isle Royale, close to the Canadian shore of Lake Superior but a part of the State of Michigan, the largest fresh water island in the world, comprising some 85,000 acres, has just been purchased by American interests from an English syndicate which owned it for many years. The deal was concluded by F. W. Nichols of Houghton and Oscar J. Larson of Duluth, the latter the agent of the United States Steel Corporation.

In Victoria, Australia, the government has specified the following antidote for cyanide poisoning to be hung in some easily accessible place in the mill: A hermetically sealed bottle containing 7½ grams ferrous sulphate dissolved in 30 c.c. water; a bottle containing 1½ grams caustic soda, dissolved in 300 c.c. water; and a tube containing 3 grams of magnesia. The ingredients are to be mixed and introduced into the patient's stomach through a rubber tube which acts as a siphon for emptying the stomach of its poison.

Pure hydrogen manufactured with a simple apparatus and from non-bulky materials, is the achievement of recent French experiments. Fine aluminum filings are mixed with a small proportion of mercuric chloride and potassium cyanide, which causes a slight rise of temperature, and produces a coarse powder, quite stable if kept dry. This powder is treated with water, about a pint to a pound, and the temperature, as the hydrogen is evolved, is kept below 160° F. by the addition of more water. At that temperature 2¼ lb. is completely oxidized in two hours, and yields 44 cu. ft. of pure hydrogen.

Zapote is a Mexican wood which grows to great size. Although the wood of this tree has considerable value for lumber, it is seldom used in that way, but is cherished as the producer of chicle, the sap which forms the basis for many chewing gums. The wood of zapote is dark red, and easily worked until it becomes thoroughly seasoned, when only the finest edged tools have any effect upon it; it sinks in water like a piece of iron. The wood takes a magnificent finish, as do nearly all the native varieties, and would be a fine medium for cabinet-making.

Nearly all wells less than twenty-five feet in depth yield water that is unfit for use, according to the general report of the State Water Survey recently issued as University of Illinois Bulletin, State Water Survey, series No. 6. Of the 868 well waters examined during the year, 60 per cent. were condemned; 85 per cent. of the wells less than twenty-five feet in depth were condemned, while only 13 per cent. of those more than 100 feet in depth were found unusable, and the deep wells were usually condemned because of the excess of mineral matter, and not because pollution by sewage was suspected.

The extraordinary power of hot silica bearing water to penetrate and microscopically replace certain substances with the utmost minuteness and faithfulness is shown in some of the deep and old abandoned workings of the Comstock mine, where not only have the timbers been partially silicified by the hot, silicious waters, but even the fine, soft, impalpable fungus growing on those timbers, and well known to miners in the timbering of damp portions of mines, is replaced by opaline silica down to the minutest fiber and showing the delicate, fernlike patterns of this parasitic growth.

The best way to get a good object lesson on the full benefits of a good blower and dust-collector system, is to go into a wood-working plant where there is an excellent system, then go into another where there is none or where the system is faulty. There will not only be a striking difference in the general appearance, with trashy accumulations around machines where there is no collector system, but there will be a difference in the appearance of the work itself. From which it is easy to understand that a good blower system is well worth while.—*Wood-Worker.*

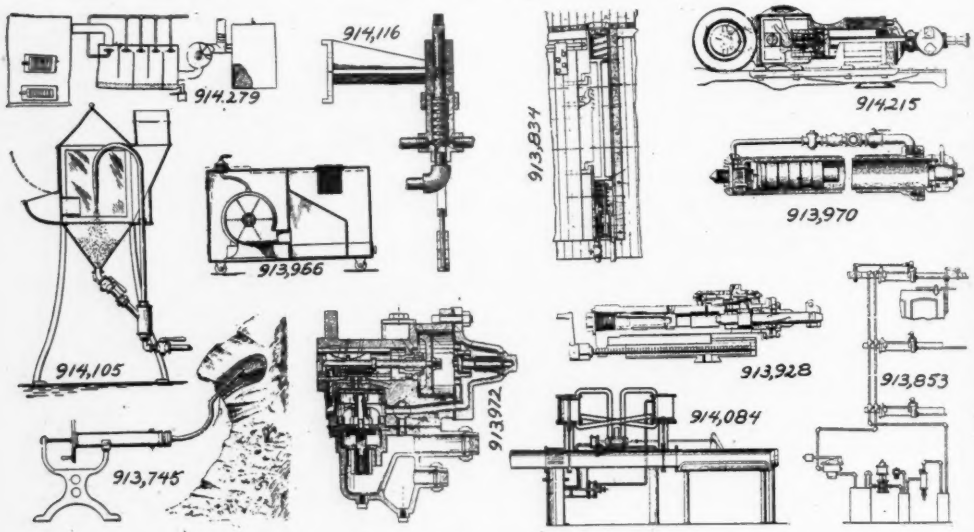
As far as pumping water is concerned, a centrifugal pump can take its suction from almost a perfect vacuum, but since it is a com-

plete failure as an air pump, a very small quantity of air in the suction under these conditions will cause it to cease pumping completely. Since the volume of any given quantity of air increases with the vacuum, and the leakage also similarly increases, the probability that air in the suction will cause trouble increases about as the square of the suction lift. If in addition to a high lift, the suction pipe is long and perhaps old, trouble can be predicted to a certainty. In view of these conditions, a 20-foot suction lift, including friction, should be about the maximum.

The government's new forest products' laboratory will be located at the University of Wisconsin. The establishment of the laboratory means the concentration of all the lines of experimental investigation of the government looking to closer and better utilization of timber and the checking of wood waste. Forest Service laboratories for timber test work at Yale and Purdue Universities and the government's wood pulp and wood chemistry laboratory in Washington will be consolidated and transferred to Madison as soon as practicable. A force of fifteen to twenty timber test engineers, experts in wood preservation, wood pulp manufacture and wood distillation will have charge of the work carried on.

The pressure of inclined rock strata in the Townes tunnel on the Carolina, Clinchfield & Ohio Ry. was greater than could be borne safely by a plain concrete lining, and therefore steel reinforcement ribs were used. These ribs are 12-in. I-beams, spaced on varying centers, from a minimum of 1 ft. to a maximum of 34 ft., depending on the pressure. Since the pressure came from one direction, the I-beams were placed on one side only, and around the arch. The side beams were given a convex curve against the pressure, and their feet were skewed to give bearing for the thrust. The concrete lining was used to an angle of 30 deg. above the springing line, and the arch finished in brick.

There is now an air tight milk can which may be filled at the dairy, hermetically sealed, and kept in this condition until the entire contents of the can are removed at the place of sale. This result is effected by the use of compressed air in the can, which forces out the contents, as needed. The compressed air is sterilized, and everything about the milk is kept perfectly clean. There is no danger from contamination by exposure to dust and dirt or flies and other insects. It is impossible to change or adulterate the contents of the can in any way from the time it leaves the dairy until the contents have been placed in the consumers' hands. The can is locked, and no liquid can be pumped into it without breaking the lock and removing the cover.



PNEUMATIC PATENTS, MARCH 2.

LATEST U. S. PATENTS

Full specifications and drawings of any patent may be obtained by sending five cents (not stamps) to the Commissioner of Patents, Washington, D. C.

MARCH 2.

913,745. MACHINE FOR FIXING BLASTING CHARGES. OLIVER F. MALCOLM, Joplin, Mo.

913,834. AIR-CONTROLLED LOCK FOR SLIDING DOORS. WILLIAM J. MARTIN, Buffalo, N. Y.

913,853. PNEUMATIC OPERATING MECHANISM FOR DOORS OR OTHER DEVICES. HAROLD ROWNTREE, Chicago, Ill.

913,928. ROCK-DRILL. JOHN A. TRAYLOR, Denver, Colo.

913,932. ROCK-DRILL. THOMAS E. ADAMS, Cleveland, Ohio.

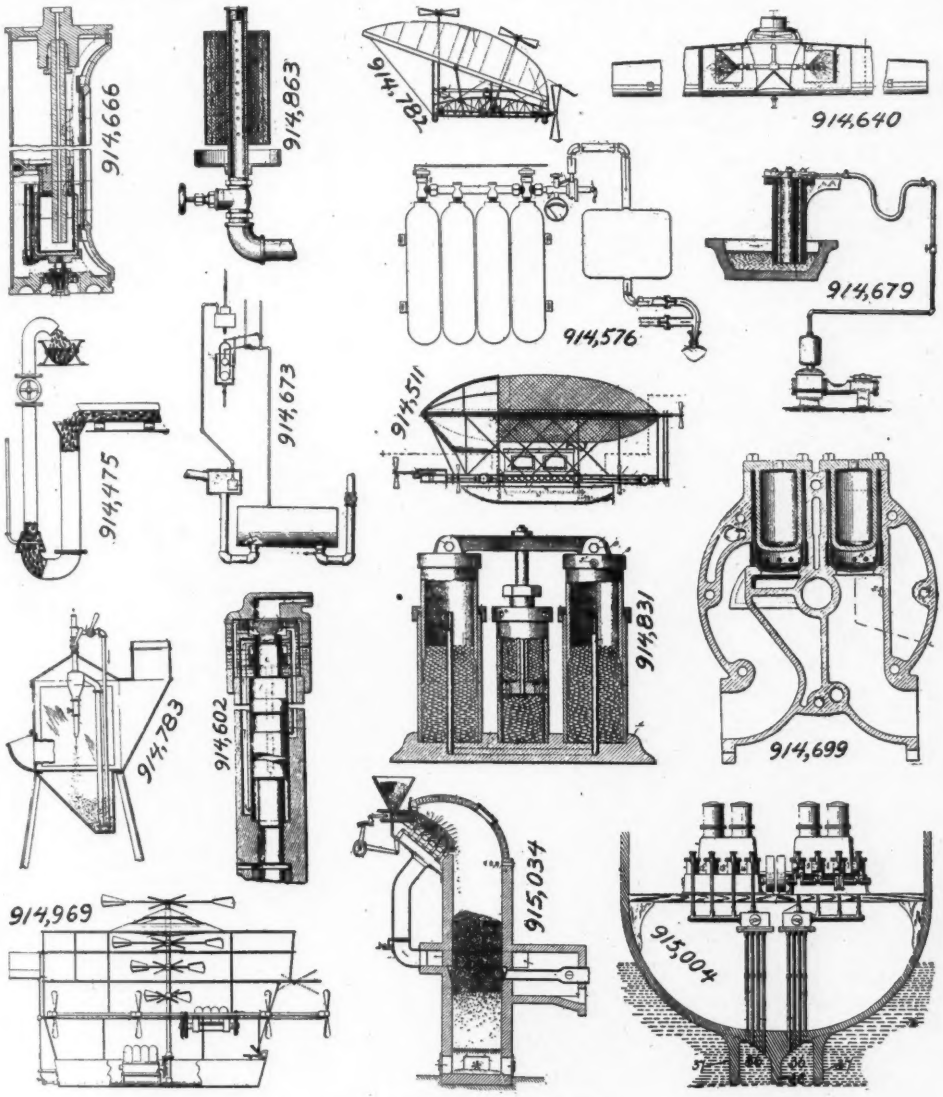
913,966. SUCTION-CLEANER. OTTO H. MOHR, San Francisco, Cal.

913,970. FLUID-PRESSURE RAM. ALFRED PARFITT, Topeka, Kans.

914,084. PNEUMATIC-DESPATCH-TUBE APPARATUS. CHARLES F. STODDARD, Boston, Mass.

914,105. SAND-BLAST MACHINE. FRANCIS P. BOLAND, Providence, R. I.

914,116. GOVERNOR FOR AIR-COMPRESSORS. ELI B. COUP, McKeesport, Pa.



PNEUMATIC PATENTS, MARCH 9.

914,215. ROCK-DRILL. THOMAS E. ADAMS, Cleveland, Ohio.
914,279. PROCESS OF OBTAINING NITROGEN FROM AIR. OLIVER P. HURFORD, Chicago, Ill.

MARCH 9.

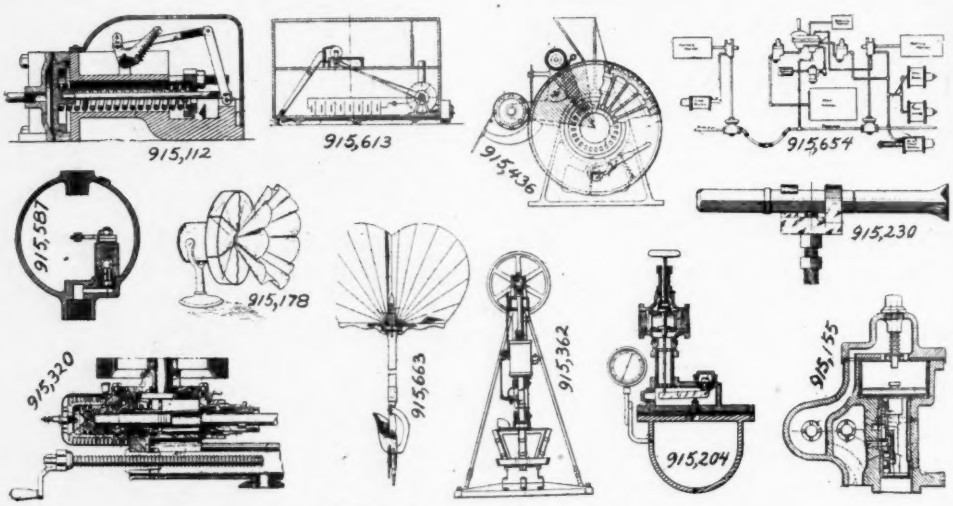
914,463. PNEUMATICALLY-OPERATED DEVICE. WILLARD C. SMITH, Kankakee, Ill.
914,475. APPARATUS FOR ELEVATING AND CLEANING MATERIAL OF A GRANULAR NATURE. FRANZ BEDUWE, Luttich, Belgium.

1. In apparatus for elevating and cleaning granular material the combination of a conduit having an upwardly and a downwardly directed portion, means for introducing the granular material after admixture with a liquid into the downwardly directed portion of the conduit, a compressed air distributing device in the lower end of the upwardly directed portion of the conduit and a receiver adjacent to the upper end of this conduit for the material and liquid as they are discharged therefrom by the air lift as set forth.

914,511. AIR-SHIP. JOEL T. RICE, Hot Springs, Ark.
914,737. ROCK-DRILLING ENGINE. JOHN G. LEYNER, Denver, Colo.
914,782. AEROPLANE AIR-SHIP. LOUIS A. BECHT, Paris, France.
914,783. SAND-BLAST MACHINE. FRANCIS P. BOLAND, Providence, R. I.
914,831. PNEUMATIC BUFFER FOR SELF-PROPELLED VEHICLES. MELVILLE P. HAYWARD, Quincy, Mass.
914,863. AIR-MOISTENER. CHARLES G. McKENDRICK, Monroe, N. Y.
914,969. AEROPLANE. HENRY MUELLER, St. Louis, Mo.
915,004. PNEUMATIC PROPULSION OF VESSELS. EDWARD WILDE, Philadelphia, Pa.
915,034. PROCESS OF GENERATING GAS. CHARLES E. LUCKE, New York, N. Y.

MARCH 16.

915,112. ELECTRIC AND PNEUMATIC GOVERNOR. WILLIAM K. RANKIN, Philadelphia, Pa.
915,155. AIR-BRAKE APPARATUS. HENRY F. BICKEL, New York, N. Y.
915,178. ELECTRIC-FAN AIR-SPREADER. NEWTON S. HILLYARD, St. Joseph, Mo.



PNEUMATIC PATENTS, MARCH 16

914,576. RESPIRATOR. GEORGE F. JAUBERT, Paris, France.
914,602. FLUID-PRESSURE TOOL. FRIDOLIN POLZER, New York, N. Y.
914,636. ROTARY TUNNELING-MACHINE. CHARLES A. CASE, New York, N. Y.
914,640. HUMIDIFYING AND AIR-CONDITIONING APPARATUS. STUART W. CRAMER, Charlotte, N. C.
914,666. VACUUM-GAGE. HENRY W. MAURER, Rochester, N. Y.
914,673. APPARATUS FOR CONTROLLING THE APPLICATION AND RELIEF OF PRESSURE TO TANKS AND OTHER APPLIANCES. ALBERT PRIESTMAN, Philadelphia, Pa.
914,679. PROCESS FOR CASTING METALS. MARTIN V. SMITH, New York, N. Y.

1. The herein described process of applying to a core of one metal an outer shell of another metal which consists in mounting the core in a mold, exhausting the air from the mold and the surface of the core, and causing the other metal to flow into the mold around the core in the same direction the air flows therefrom.

914,699. COMPRESSOR-VALVE. NIELS A. CHRISTENSEN, Milwaukee, Wis.
915,204. PRESSURE-REGULATOR. THOMAS MONTGOMERY, Sarnia, Ontario, Canada.

1. In automatic regulating devices for fan engines and the like, the combination with the main air reservoir filled with air at a predetermined pressure and hermetically sealed and provided with a top having an orifice therein and a flat outer surface, of a diaphragm lying normally parallel with the surface, a supplemental top having an inner surface parallel to the plane of the outer surface of the top, packing rings holding said diaphragm normally midway and parallel to the outer surface of the top and inner surface of the supplemental top, the supplemental top being provided with a central orifice and an outer chamber located and communicating with the steam line, a valve in the steam line and means between the valve and the diaphragm operated from the diaphragm for adjusting the position of the valve as and for the purpose specified.

915,230. WATER ATTACHMENT FOR DRILL-STEELS. JAMES H. SINCLAIR and GUY D. NEILL, Denver, Colo.
915,320. GASOLENE-OPERATING ROCK-DRILLING ENGINE. ROLLAND S. TROTT, Denver, Colo.

915,362. ATMOSPHERIC STAMP. CHARLES H. KRAUSE, Keweenaw Bay, Mich.

915,366. AUTOMATIC PENUMATIC PIANO. AXEL F. LARSON and KARL O. OSTERGREN, Chicago, Ill.

915,436. VACUUM DRUM-FILTER FOR SEPARATING SOLID SUBSTANCES FROM LIQUIDS. HEINRICH HENCKE, Charlottenburg, Germany.

915,587. PRESSURE-REGULATING DEVICE FOR GAS AND STEAM. AUGUSTE GAUDET, Paris, France.

915,613. PNEUMATIC SWEEPER. WILLIAM P. LEISTER, Cliffside, N. C.

915,654. AIR-BRAKE SYSTEM. JOHN S. BARNER, Albany, N. Y.

915,663. FAN. FERDINAND D'AVERSA, New York, N. Y.

MARCH 23.

915,723. AIR-BRAKE TRIPLE VALVE. WALTER M. AUSTIN, Swissvale, Pa.

915,724. FLUID-PRESSURE AIR-BRAKE. WALTER M. AUSTIN, Swissvale, Pa.

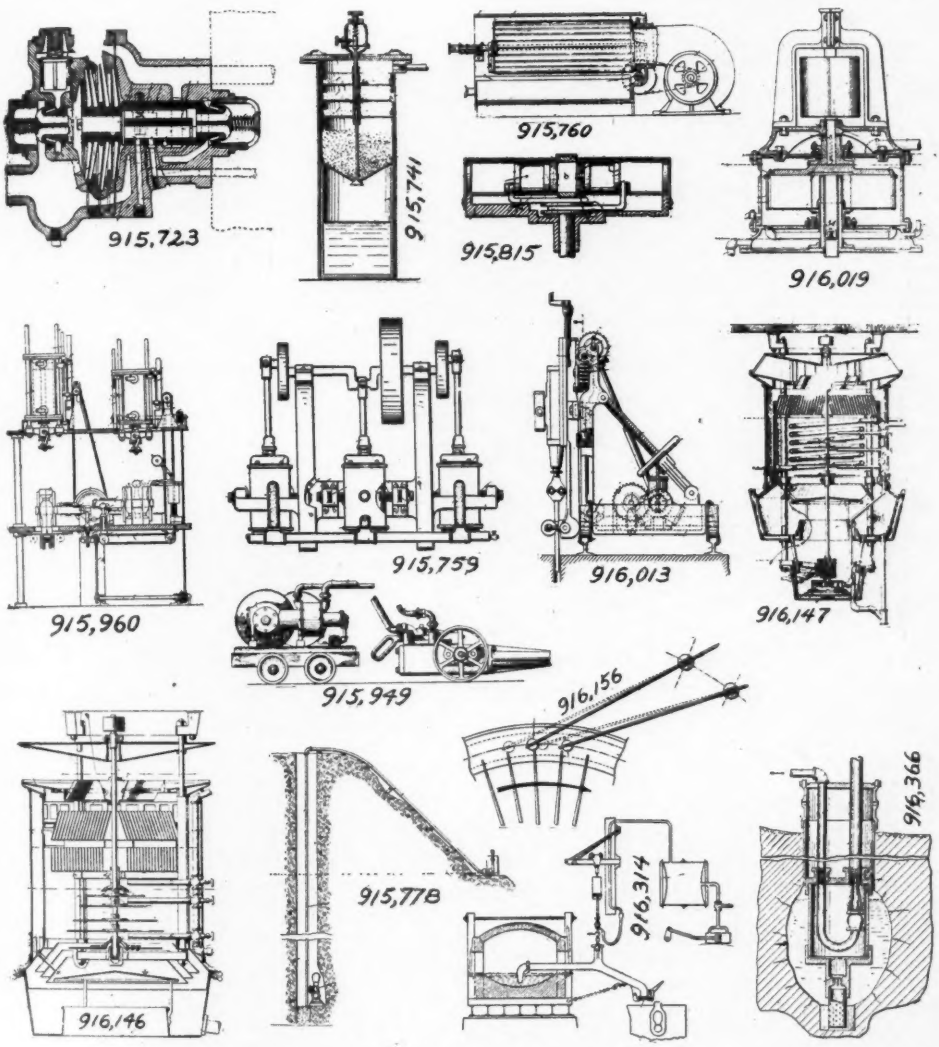
915,735. HANDLE-LOCK FOR PNEUMATIC TOOLS. GEORGE L. BROWN, Louisville, Ky.

915,741. APPARATUS FOR OPERATING RAILWAY-SIGNALS. CLYDE J. COLEMAN, New York, N. Y.

915,759. AIR-COMPRESSOR. GERALD FOLL, Winnipeg, Manitoba, Canada.

915,760. APPARATUS FOR REGENERATING AIR. RICHARD VON FOREGGER, New York, N. Y.

915,778. WATER-ELEVATING APPARATUS. JAMES S. LAWRENCE, San Javier, Mexico.



PNEUMATIC PATENTS, MARCH 23.

915,813. MOTIVE-FLUID-OPERATING TOOL. DANIEL S. WAUGH, Denver, Colo.
915,815. AIR-COMPRESSOR. HENRY WILCOX and FRANK BRABSON, Newark, N. J.
915,949. MINING MACHINERY. ARTHUR H. GIBSON, Easton, Pa.
915,950. PULSATOR. ARTHUR H. GIBSON, Easton, Pa.
915,960. GLASS-BLOWING MACHINE. HERMANN HILDE, Rosswein, Germany.
916,013. CHANNELING-MACHINE. WILLIAM PRELLWITZ, Easton, Pa.
916,019. METHOD OR PROCESS OF COMPRESSING AIR. WILLIAM K. RICHARDSON, Leavenworth, Kans.
916,114. FLUID-PRESSURE CUT-OFF. REX DAVIS, Salem, W. Va.
916,146. MACHINE FOR HUMIDIFYING AND CLEANSING AIR AND CONTROLLING ITS TEMPERATURE. DANIEL P. GOSLINE, Boston, Mass.
916,147. MACHINE FOR CONDITIONING AIR. DANIEL P. GOSLINE, Boston, Mass.

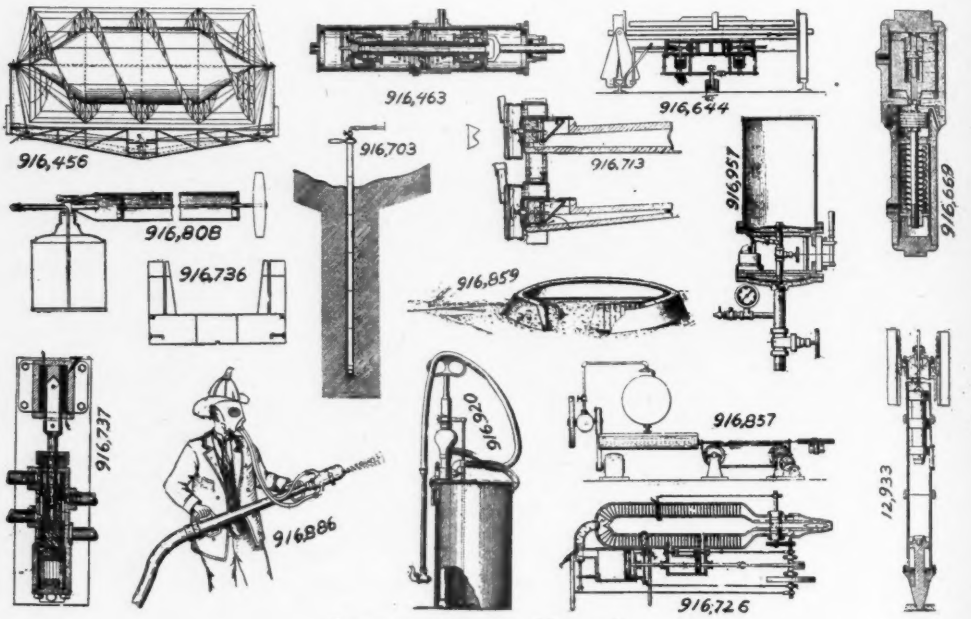
1. The combination with a piston hammer drill, of a drill bit whose diameter of cut is wider than the largest outside diameter of said piston hammer drill, said piston hammer drill being adapted for entrance into the hole made by it, substantially as described.

916,713. PNEUMATIC PIANO-PLAYER ACTION. GIOVANNI M. DE JULIO, New York, N. Y.

916,726. POWER-FLUID GENERATOR. CHRISTOPHER JOHN LAKE, Bridgeport Conn.

1. The combination in a power fluid generator of two generating chambers; and apparatus for charging one chamber with air and a hydrocarbon and the other chamber with air and water, said apparatus being driven by pressure derived alternately from each chamber when charging the other chamber.

916,737. DEVICE FOR CONTROLLING AIR-BRAKES OF RAILWAY-VEHICLES AND ELECTROMOTIVE ENGINES. JACOB M. LONG, Los Angeles, Cal.



PNEUMATIC PATENTS, MARCH 30.

916,156. QUANTITY-REGULATING DEVICE FOR ROTARY FLUID-COMPRESSORS. ALBERT HUGUENIN, Zurich, Switzerland.
916,314. PNEUMATIC APPARATUS FOR DISCHARGING FURNACES. SAMUEL E. HITT, Pittsburg, Pa.
916,366. EJECTOR FOR OIL-WELLS. JAMES W. PLIMPTON, Oil City, Pa.

MARCH 30.

916,456. AIR-SHIP. OSCAR J. LAISY, Cleveland, Ohio.
916,463. FLUID-PRESSURE ENGINE. WILLIAM T. LEWIS, Columbus, Ohio.
916,567. FRESH-AIR-TREATMENT APPARATUS. LAWRENCE P. LEONARD, St. Cloud, Minn.
916,644. PNEUMATIC RAIL-BRAKE. POWELL O. ADAMS, Cameron, Tex.
916,669. RETAINING-VALVE FOR AUTOMATIC AIR-BRAKES. JOHN M. CARTER, Memphis, Tenn.
916,703. ROCK-DRILL. BENJAMIN HASTINGS, Cleveland, Ohio.
916,738. SWITCH - OPERATING DEVICE. THOMAS H. LORD, Altoona, Pa.
916,764. PNEUMATIC PIANO. AUGUST NORDEEN, Newcastle, Ind.
916,765. PNEUMATIC PIANO. AUGUST NORDEEN, Newcastle, Ind.
916,808. SPRAYER. HENRY A. VOELKNER, Detroit, Mich.
916,857. AIR-COMPRESSOR. LEWIS A. GATES, Oroville, Cal.
916,859. APPARATUS FOR MINING GOLD AT THE BOTTOMS OF FLOWING STREAMS. LEANDER F. GILMAN, Sacramento, Cal.
916,886. AIR-ACCUMULATOR. WILLIAM F. MERRYMAN, Denver, Colo.
916,920. TANK AND SPRAY PUMP. WILLIAM L. DEMING, Salem, Ohio.
916,957. PRESSURE-REGULATOR. AUGUSTUS C. DURDIN, JR., Chicago, Ill.
12,933. SUBAQUEOUS ROCK - BREAKER. CHARLES L. ROWLAND, New York, N. Y. (Reissue.)

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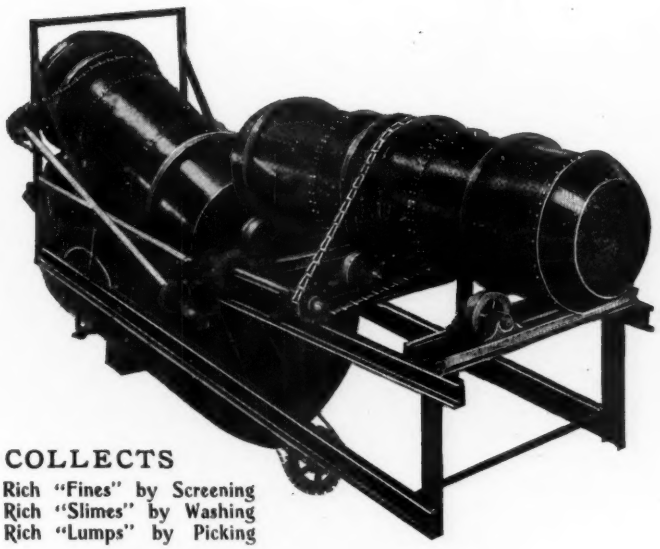

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Bulletin 960 A.

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